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MR. DAVID DAVIES, M.P.

MINING IN SOUTH WALES: MR. DAVID DAVIES, M.P.

THE South Wales coalfield occupies the greatest part of Glamorganshire, where it attains its maximum breadth of twenty-one miles. In its length, which extends to eighty-nine miles, it stretches through five counties. It is said that the South Wales coalfield is the most interesting of all the coalfields of Great Britain on several accounts. It contains the largest quantity of coal. The coal is remarkable for the great variation of quality, and the peculiar deposits require peculiar engineering skill for their development. The development of the coalfields dates from the time when coal superseded charcoal in iron-smelting. It is appropriately called the South Wales bason, as the measures crop out on all sides. The coalfield over the extreme edges of this bason measures some 1,200 square miles. Without discussing at full the distribution of coal, and the peculiarities of the strata, we shall give some notes, derived from a prolonged sojourning in Wales, of collieries and colliers, and making a selection from many names that might suggest themselves, we will say a few words respecting the now well-known member for Cardiganshire, who has been mainly instrumental in opening up the minerals of the Rhondda valley. There is now a considerable literature belonging to the coalfield, one of the latest and best publications being an important and voluminous paper, read by Mr. T. Forster Brown, at a recent meeting at Cardiff of the North of England Institute of Mining and Mechanical Engineers. Much still remains to be done for the full elucidation of the subject.

It is said that "we know less, perhaps, of the succession of the coal strata than of any other in the United Kingdom, though they are the most important of all." Geological science halts in its nomenclature of the coal measures. There are a set of words used of the coal measures of South Wales, "rock cliff," "cliff quar," "pins," "undercliff," for which an entirely different terminology exists in the north. The subject of the development of the coal measures is beset with unsatisfied problems. For the classification the reader must be referred to publications that possess diagrams and plans of section. The coalfield rests on millstone grit, which reposes on mountain limestone. Beneath the limestone is the old red sandstone, "the grandes

exhibition in England and Wales," as Sir Roderick Murchison calls it, and below is the upper, middle, or lower Silurian. Some of the strata are singularly contorted with faults. The quality of the coal varies exceedingly, from the pure anthracite or stone-coal of the Pembrokeshire district, to the highly bituminous coal of the Newport district. As a rule the change is gradual. The intermediate qualities are known as semi-bituminous, smokeless, bastard anthracite. In the Aberdare and Rhondda districts the seams are carbonaceous. The main development of the coalfield is confined to eastern Glamorganshire and Monmouthshire. The great bulk of the smokeless steam-coal worked from the white-ash series—the series which has really made Wales famous for coal and iron—is obtained from the Merthyr, Aberdare, and Rhondda valleys.

A question of very great importance is involved in the statistics of the wrought and estimated unwrought coal in the district. Mr. Forster Brown calculates that the present rate of fifteen million tons represents $\frac{1}{2437}$ part of the workable coal. By many, however, this estimate will be considered as too sanguine. The estimate made by colliery owners and engineers in South Wales, as evidenced also in Mr. Vivian's great speech, always leans to the favourable side. The total consumption of coal in the country, which can hardly be less than a hundred and twenty million tons a year, points to a date when our mines will approach the limits of a commercial possibility. The author of a very interesting little work, "Thirty Years in a Mining District," complains that the collieries in South Wales are being worked with very little consideration as to whether they will last one hundred or a thousand years, and that the owners, "in their anxiety to avail themselves of a large get of the best coal, at the lowest rate possible, other veins of coal, which at no very great length of time would be almost priceless, are being destroyed or cut off through mismanagement." The justice of this complaint is stoutly contested by the coal owners.

We have been up the valleys we have named, the Aberdare, Rhondda, and Merthyr valleys, but on this occasion we limit ourselves to the Rhondda valley. A run up the prosperous Taff Vale line brings us to the Pontypridd Junction, where a branch line runs to the head of the valley. The Rhondda river flows with a swift dark current beneath precipitous banks. Bold hills rise behind, partially clothed with woods, some of which are cut down or thinned every ten years for the chemical works in the valley. Some years ago the hills were often covered with larch woods, which have been cut down for pitwood, and by a sad improvidence have never been replanted. It is now necessary to import pitwood from abroad. Above these woods the hills rise high and sterile. They are covered by coarse grass, heather, gorse, and bracken ferns, and the summits are formed of massive cliffs and the *débris* of sandstone. We perceive branch lines running to different collieries. The trains of trucks and engines belong to the colliery proprietors, and are carefully marshalled and arranged with a view to their different destinations. There is also a regular telegraphic service between the works and the business offices in Cardiff. Coming to a nearer inspection of the works—we are here more especially speaking of those of the Ocean Collieries—we see tram after tram of coal raised from the pit's mouth with the utmost rapidity. Each tram is weighed and checked off by two clerks, one in the interests of the employers and the other in the interests of the men. Close at hand you may observe the process of screening the coal. The instrument which ascertains the amount of the coal passed through the screens is the famous Billy Fairplay, a personage which is extremely unpopular among the men, as a deduction is made from the hewer if the amount exceeds a given weight, the contract with the men being for large coal. The coal is now "colliery screened large;" it is frequently screened again at the time of shipment, when it becomes "double screened." We next descend into the mine, travelling downwards with the speed of an ordinary train; perpendicular travel being, however, by no means so pleasant as horizontal. Each subterranean traveller is provided with a lamp, and they keep close together that they may not be lost in the many miles of underground tramway. The ventilation seems thoroughly good, and when we approach the neighbourhood of some immense furnace that takes its ten tons of coal a day, the air resembles a mighty mountain wind. The underground haulage is mainly done by machinery. As the trams come thundering past we crouch into little recesses at the sides. In the roofs of the workings we see there has been a perfect forest of timber employed, which makes up a very large part of the working expense of a mine. The mines of the Rhondda and Aberdare valley are mainly worked on the Longwall system, which is found to reduce labour, increase the output, and promote ventilation. The roof settles down permanently behind the working face, and the whole of the coal is worked away with the exception of the large pillars at the shaft bottom.

We go from the tramways through the short sidings to the working face, where the hewers are busy with their implements. With these men we are greatly interested. We greatly regret that the men, with generous, credulous natures, are so often led aside by agitation, and that nearly all their political interests are concentrated and absorbed in strikes. We observe with regret not far from the pit's mouth, low-looking taverns, where we are told immense sums are realized. The warm-hearted Welsh are very fervent in zeal for their chapels. Their main literary and patriotic interest is shown in the remarkable institution of the Welsh Eisteddfod.

There is no one who has been more identified with the progress and prosperity of the principality of Wales than Mr. David Davies, M.P. He belongs to the order of men who have risen from the ranks by their energy, frugality, and ability. He was the great railroad maker of Wales. Line after line has been laid by him, perfecting communications throughout the principality, and opening up wide districts to trade and travel. He was nominally contractor to these lines, but in reality he bore the whole brunt and burden of most of the undertakings. He found the skill, capital, and labour by which they were carried through. At present he has the largest share in one of the largest coal mines in the principality.

Twenty years ago, the time of the sharp winter of the Crimean war, the coal trade in Wales was at a very low point of development. The output of coal from Cardiff was at that time about a million of tons. It is now about nine millions. Coal was 12*s.* 6*d.* a ton; the cost of production was 3*s.* 6*d.* to 4*s.* a ton. Prices are wonderfully changed now. At the time we are speaking of, the prices quoted were considered extremely high, and the coal owners were in high spirits. Some years later Mr. Davies, having done memorable work in railways, was induced to come into coal mines. The famous valley of the Rhondda was then almost virgin soil. The few pits that had been sunk were not of much importance. The collieries of the Ocean Steam Company, as they are called, now occupy alone between four and five thousand acres. The output of coals is extraordinary; the railway hardly seems competent to meet the demands of the mineral trade. It was a somewhat singular incident which induced Mr. Davies to go into the Rhondda valley. He had arranged to buy a large colliery near Aberdare, and a certain evening was fixed for paying over the money. A few hours before, it became known to the gentleman who was acting for Mr. Davies, that there was an awkward downthrow fault not far in advance of the existing workings. The purchase was consequently stopped at the last moment, and this circumstance eventually involved the rapid development of the Rhondda valley.

Mr. Davies was born at Llandinam, in Montgomeryshire. He was originally a sawyer on the estate which he afterwards purchased. He is a man of remarkable muscular development, and intense energy and great enterprise. His first contract was to cut a turnpike road, through a steep hill-side, from Welshpool to Llanfaircaereinion. This was a difficult bit of road engineering. It was, however, very skilfully effected, and revealed Mr. Davies's aptitude for this work and his own zest and tact for this kind of business. Often, when his workmen were disheartened at any difficulty, he would apply his own hands and shoulders to the obstacle, and encourage them to perseverance. For a considerable time he occupied himself with small sub-contracts on railways, so many yards or furlongs, from which he invariably realized considerable profits. His keen eye would detect the possible advantages of a contract, as well as the best means of executing it. He bounded from the smallest to very large contracts. He would take whole railways. We believe that his first contract was the Oswestry and Newtown; almost his last what is called the Manchester and Milford line, the actual line laid out being from Carmarthen to Aberystwith. During the time he was working this line, he contested Cardiganshire in the Radical interest against Colonel Powell, and after that gentleman had withdrawn, against Sir Thomas Lloyd, of Bronwydd. Mr. Davies, being a most zealous and munificent supporter of the Calvinistic Methodists—a denomination that predominates in Cardiganshire, where it had its birth—Sir Thomas Lloyd found him a very formidable opponent. Later, when Sir Thomas and Mr. Davies had shifted their candidature from the county to the boroughs, Sir Thomas found his rival's popularity so strong, that he allowed him to walk over the course. Mr. Davies has added to his popularity by the immense and hearty entertainments which he gave to all the men in his employ on the occasion of his son coming of age. He is a rigid Good Templar, but provided some twenty thousand bottles of aërated waters for the refreshment of his guests. Colliers, however, are thirsty souls, and it is calculated that another twenty thousand could have

been disposed of, especially if an alliance with stimulating liquors had been obtainable.

Mr. Davies's first parliamentary appearance was a decided success, and was remarked by Sir Stafford Northcote as being eminently "characteristic." No one can look at the honourable member—the big head, the shrewd aspect, the immense form—without being impressed by him. He has showed himself a far-sighted, large-hearted, liberal man, moving within a somewhat narrow groove of ideas, but moving within that groove with intense force and energy. As an authority upon railways and coal mines he ranks very high. At the present time the great prosperity of the coal trade in Wales has received a decided check. There has been a fall of prices, which, it is expected, will necessitate a further reduction of wages.

The output of coal, however, has never been so great as during the past months of the present winter. Coal is, after all, in its infancy in the South Wales district, and the possible applications of steam are incalculable. Many new "winnings" are projected or in progress in the South Wales mineral basin. Among these is Harris's Navigation, where the use of the diamond drill is adopted, the works of the Great Western Company at Pontypridd, and various works in the Rhondda Valley, comprising works projected by one of the partners of the Ocean Steam Company at Cwm Clydach, where within the last few weeks a valuable seam of coal has been struck at a depth of 380 yards. Four new pits are also being sunk in the property of the Ocean Company.

F. A.

SOCIETY OF ARTS STOVE PRIZES.

WHEN, some two years ago, the Council of the Society of Arts announced that they had been entrusted by an anonymous donor with the sum of £500 to be spent with a view to encourage the development of improved means for the economic use of fuel in private dwellings, some sanguine expectations were aroused as to the advantages likely to accrue from a scientific investigation of the subject. Since the time of Count Rumford, eighty years ago, it does not appear that any investigations of a scientific character have been made in reference to stoves used for purely domestic purposes. Various exhibitions of stoves have taken place; assertions innumerable of the superiority of one or other of the arrangements before the public are widely diffused; testimonials as to the percentage of fuel saved are easily—indeed too easily—obtained; for, by a judicious comparison of advertisements, it might not be impossible, by the super-addition of one statement to another, to discover a stove which, without more than one pound of fuel per day, ought to give radiant heat and light sufficient to satisfy every want. Still, with all this, we have not had any further principles enunciated than those put forward by Rumford.

There was, therefore, a great want of reliable and accurate information about our domestic stoves and fire-places as regards the amount of heat that could be developed, the proper shape for the most economical consumption of the fuel, the amount of ventilation secured by the various grates in use, and other similar points. Unfortunately this ignorance still continues; for the plan adopted by the Society, of offering a series of prizes for stoves, has failed to produce any that the committee appointed can recommend as worthy of a prize.

It would, doubtless, have been wiser for the Society of Arts, and more to its own credit, if the Council had decided to employ the funds at their disposal in investigating general principles, instead of helping rival tradesmen to advertise their wares; but it is now rather late to make any suggestions on that point. The system of offering rewards to inventors was of the greatest use in the infancy of mechanical knowledge, and the Society of Arts did so much in years gone by to foster inventions, that it may be difficult for it to get out of its old track.

It is also a matter for regret that the Committee have not found themselves in a position to publish a detailed account of the results of their experiments. That such a record was kept we are in a position to be certain, and we also know that the whole system of testing was most elaborate in its character, and most carefully carried out in the minutest details; but we understand that, being arranged with a view merely to decide the merits of competing apparatus, it is not considered suitable for publication. While we regret that this is the case, we can quite understand that the members of so influential a committee as that which the Society of Arts was fortunately enabled to select, might well hesitate to put their names to a record of experiments which could not be authoritatively put forward as a basis for practical application in the future. For such a committee, no one could better have represented the engineering element than Mr. F. J. Bramwell; Prof. Abel was equally fitted to consider chemical questions; and Capt. Douglas Galton is the recognized authority on the special subject of house warming and ventilation. We may therefore accept it as a fact that, in the opinion of the best-qualified judges, none of the numerous systems of domestic fire-grates are at once sufficiently good and sufficiently novel to deserve public mention and reward. It is to be remembered indeed that there might have been a natural objection on the part of manufacturers to have a comparison published of the relative merits of their own and other apparatus, and that the committee had no authority to do more than award a prize. As they could not do this, they may have felt unwilling to offer any opinion on the merits of the competitors. Be this as it may, they have given none, and we are consequently not provided with the full details of the results obtained.

As the experiments were of a very complete character, and as no description of them has yet been published, perhaps the following general account of them may prove interesting. That the special results from each apparatus, and the averages struck by the committee from these results, may hereafter prove useful, and that the Society of Arts will see the advisability of not letting the question drop, but of investigating still further the principles of true construction for our stoves, is sincerely to be hoped.

The prizes offered were divided into several classes, so as to include stoves for warming and cooking by coal and gas, as well as for any new apparatus fit for domestic use, and burning any other sort of fuel whatever.

Having decided that examination alone of the stoves would be insufficient, and that only actual trial would test their merits, arrangements were made for the erection of testing-rooms in the grounds of the International Exhibition, and also for the exhibition in 1874 of the stoves accepted for competition.

Six rooms, each measuring 15 ft. in length, 15 ft. in breadth, and 15 ft. in height, were accordingly erected in a continuous line. As it was expected that stoves of very different forms were likely to be sent in, the walls in the rooms were flat, and had no projecting chimney jambs. Each competitor was allowed to make such erection for his stove as he deemed best, with the condition that the flue of the stove must enter the chimney erected, so that the heat of the room might be derived through the stove only, and not through a chimney added to it for the purpose of diffusing heat.

The chimney was built in concrete, and formed round a core 9 in. in diameter; where the concrete ended, a metal tube was placed, thus giving to each chimney a height of 25 ft. from the floor of the room.

The walls were plastered in the inside, and to prevent any great cooling influence from the admission of cold air when the door was opened, porches with doors were erected in each case, so that the doors of the room need not be opened until the door of the porch was closed. Bunkers with lids and locks for coals were placed at the door of each room, within the porches.

The ceilings of the rooms were flat, and the covering was rendered rainproof by coatings of pitch or asphalte. Glass tubes $\frac{1}{2}$ in. in diameter were passed through the covering and walls of the rooms, for the insertion of thermometers as required.

Ventilators cast in iron from the same pattern were placed so that two of them could be connected, if required, to such stove arrangements for the warming and admission of fresh air as the inventor might wish. Others were placed in the room for the admission, if required, of the outer air. Being of cast-iron, the area of these ventilators was fixed, so that an accurate calculation of the air passing through them in a given time might be made.

At an elevation of 12 ft. above the floor, a tube of $\frac{1}{2}$ of an inch in diameter was inserted into the chimney for the purpose of introducing a thermometer, to ascertain the temperature of the escaping products. Immediately above this tube, and at an elevation of 12 ft. 6 in. above the floor, a small door was arranged for access to the interior of the chimney, and for the insertion of an air-meter, by which to ascertain the velocity of the ascensional current of the gaseous products of combustion and the heated air. Pipes for water and gas with meters for measuring the quantity of gas used and arrangements for regulating and examining the pressure under which the gas was being supplied, were placed as seemed most convenient. The floors of the room were concrete. The apparatus supplied for testing consisted of thermometers, air-meters, hygrometers, a barometer, and an electrical apparatus. As the committee had decided that the preliminary tests should be scientific, no preparations were made for actual cookery. The temperature of the ovens by inserted

thermometers, the ventilation of the ovens by the air-meter tests, and the time elapsing before given quantities of water reached the boiling point, were considered to give sufficient indications.

The stoves intended for competition were delivered at the Exhibition building by December 1, 1873. There were 204 stoves tendered, and of these 107 were selected for the purpose of being tested. These 107 stoves may be classified as follows:—59 stoves for use in ordinary dwelling-rooms, for warming and ventilating the same, and 18 for use in kitchens, using coal as fuel; 17 stoves for use in dwelling-rooms, and 13 for use in kitchens, the fuel consisting of gas.

These were all tested by the appliances described above, during a period extending from first to last for 142 days, and it was not until this lengthened series of experiments was completed that the committee decided on their report.

That the committee were not able to discover any apparatus superior to the very imperfect arrangements already well known and before the public is not, indeed, a cause of surprise to anyone who has studied the subject of warming and ventilating houses for himself. Valuable as our open fire-places are for purposes of ventilation, it is certain that they are, as regards the amount of heat given into the room, the most wasteful and expensive contrivances possible. By far the largest amount of heat is absolutely lost by being spent in heating air which rushes up the chimney, and is, without any heat being usefully abstracted therefrom, discharged into the air above. How much heat is radiated into the room, and how much sent up the chimney, we have yet to learn. From such experiments as have at various times been made, it would appear that the amount thus utilized is something between three and eight per cent. of the total available heat. It seems probable that reasonable and sufficient allowance has been made to meet the unknown as well as known requirements of carbon in the changes it undergoes in the process of combustion, if of the total heat contained in it fifty per cent. be allowed, in order that thus these changes may be effected. What these changes are, and how they are or are supposed to be accomplished, are questions for scientific chemistry to investigate and answer. With the heat thus said to be necessary for the purposes of combustion, the practical part of the question is not concerned. There remains, however, fifty per cent., which chemistry informs us is not thus required, and may, therefore, be entrapped and utilised. To the designers of stoves for domestic purposes this fifty per cent. of heat must be regarded as entrusted.

As we said, we ourselves do not wonder that the committee have thus failed to detect any marked exceptions from the old and even exhausted track of schemes based upon principles so clearly and emphatically established by Count Rumford about the close of the last century. Although these principles are as important now as they were important and novel then, yet it was to be expected that our domestic comforts might have shared in improvements which recent progress in physics and chemistry has conferred upon manufacturing industry.

One or two illustrations may make clear the reasons for such an opinion. There is the instruction to be derived from the combustion of carbon for light or heat, as in the Argand and Bunsen burners. There is the well-known fact that phosphorus burns in oxygen with a brilliant light, but hydrogen in the same gas with scarcely any light but with more heat, and yet if lime be introduced the light of the latter exceeds that of the former.

If attention be directed to the relation which the carbon particles hold as to what may be called their juxta-position to the oxygen ones, other considerations very suggestive in relation to domestic fireplaces present themselves.

Hitherto all domestic fires have derived the oxygen required for the combustion of the carbon in an adulterated form in combination with nitrogen. When, however, other sources than the atmosphere furnish the supply, then the effect of a more perfect combination of the two can be studied.

In the case of gunpowder these particles are, by a process of mechanical admixture, brought into as close juxta-position as mechanical means can accomplish. The effect of this aggregation of physical atoms is the production, under the influence of heat, of a power which, estimated arithmetically, and converted into heat by some such process as light is converted into heat in the Bunsen burner, would from a known amount of carbon produce results in the raising of temperature far beyond what has yet been obtained from the same amount of carbon as ordinary fuel, deriving its oxygen from the atmosphere.

Again, if these views be carried further, and the effect of carbon, not in *physical*, but in *chemical* combination with oxygen, be regarded, then the development of energy which may be deemed another name for heat, becomes so great as to have hitherto surpassed our powers of measurement. This is the case with the molecule of nitro-glycerine, in which the carbon, oxygen, and nitre are in a more close proximity than any mechanical or physical arrangements could accomplish. Hence those effects, which, although hitherto employed for purposes of destruction, may yet be, not only suggestive, but perhaps ere long utilized for the heating of our dwelling rooms. Further, chemistry supplies numerous instructive illustrations of the development of heat and light (jointly or separately), in such cases as sulphuric acid and water, iodine and phosphorus, sugar and chlorate of potash.

Such considerations as these, based upon the investigations of chemists, and other considerations drawn from our daily experience, suggest the thought that in the combustion of fuel we have followed the habits of a former, and neglected the teachings of the present age. Those other considerations are, that if we wish to mingle substances they are either by solution, trituration, grinding, crushing, or some similar operation, reduced to a solvent or a powder. To facilitate chemical combinations these are the preliminaries. Now as to fuel. The habits of the people are the converse of the habits of chemists, and it is worthy of consideration whether the small dust of coal is not a far nearer approach to the state in which it may be efficiently utilized, than the solid lumps in which either naturally or artificially it is presented for use. Add to the foregoing, that it was in the atomic state the coal first imprisoned the heat we now seek to set free, and the suggestions now made will not seem so at variance with reason, as they very clearly are with extensive prejudices and long-established habits.

It is quite clear that not only in domestic fire-places, but also in furnaces of every kind, a much larger amount of heat exists than is utilized as we desire, hence the greater need for a careful revision of the principles which have influenced the construction of these appliances.

Fuel, as supplied to our ordinary grates, is in the solid lump; in fact, in as uninviting a form for combustion as it can be made to assume. This form and fixity of solid carbon must first be destroyed, and this has to be done by the heat first produced from some extraneous source, and then from the carbon itself. We thus have it first in the granular, then in the liquid, and then in the gaseous, and then, perhaps, in the chemically compound state. Change is superadded to change, and no one can deny that thus much of the effect is neutralized which we are endeavouring to produce. To supply air freely is the generally recognized plan which is carried on, without any special arrangements to meet those changes in the combinations of carbon upon which the development of heat depends.

To some the thought may present itself that the idea the heat received by the air within the room being so small in proportion to the total is disproved by the heat which a thermometer records within an oven screen, or even by that shown by a thermometer held in the hand when on a wintry day a person draws near the fire for warmth. Assume that there is an increment of 25° F., and that the thermometer is being held at three feet from the radiant source, then, by the well-known laws of radiation, a thermometer on an opposite wall 15 ft. off would have its temperature raised only on the proportion of 1 to 25, or, in the supposed case, 1° F. only.

With regard to common modern cooking ranges there is one thing which always seems unaccountably neglected. The makers of kitcheners seem to hold many different opinions as to what are the requirements of ovens when adapted for any special purpose and so they multiply them, and it is no rare circumstance to find even so many as five ovens connected with one fire. These ovens, or according to the use to which they are applied, closets, require different temperatures. Very few of the designers of kitcheners appear to know this. Names are given to the ovens—such as "Roaster," "Baker," "Plate Warmer," but no provision is even made for the special regulation of suitable temperatures. Sometimes the oven that first receives the heat from the fire is named "The Roaster"—then the second oven, or that which had only the heat which the first oven had not absorbed, was called "The Baker." As a matter of fact, an oven for baking bread should have a thermometric temperature varying from 350° F. to 450° F., whilst one for roasting meat is properly heated at a temperature between 180° and 200°. Again, the provision for ventilation in the latter should be ample. In the former—or that for baking bread—provision for ventilation is not required. If the "roaster" is not well and sufficiently ventilated, meat is as it were parboiled in an atmosphere of vapour; if the "baker" is ventilated, bread is dried and the outside often becomes tough and hard.

Such are some of the ideas suggested by a consideration of the whole subject. It is one which we are glad to see occupying the attention of men of science, for it is quite idle to expect any advance from the ordinary manufacturer. We want some fresh principles to go upon, and these science only can supply.

GEMS OF INDUSTRIAL ART.—VASE.

is there any fear that research in this direction will go unrewarded. It is in such directions as these that great fortunes are to be made. There exists a great, a universal want; the man who provides what is required will be a benefactor to his species, and will secure wealth for himself.

THE PRACTICAL NOTE-BOOK OF TECHNICAL INFORMATION USEFUL TO STUDENTS AND WORKMEN.

(93.)

THE Elements of Timber Construction.—It having been suggested to us that a series of notes and illustrations somewhat on the same principle as those given under the head of "The Elements of Iron Construction," would be a useful companion to that series, we now take up the subject, and trust that we shall be able to make it practically useful and suggestive, the first department which shall occupy our attention being that of *floors*.

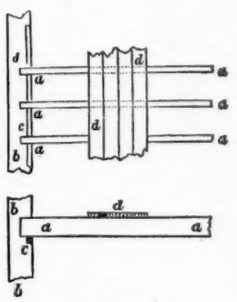

Fig. 495.

Floors are of three kinds—(1) "Single" flooring; (2) "Double" flooring: and (3) "Double Framed" flooring. The constituent parts of these will be learned from the description of the three following diagrams:—(1) SINGLE FLOORS.—The "joists" *a a*, fig. 495, are placed parallel to each other, at distances which

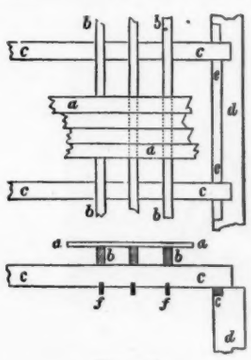

Fig. 496.

should not exceed 14 in. from centre to centre. They rest in common work simply on the walls, *b b*, at each end; but in superior work they rest upon "wall plates," *c c*, which are built into and run along the wall at right angles to the joists. Where wall plates are used, the joists are either simply spiked to the plates, or first notched and then spiked. The "flooring boards," *d d*, run at right angles to the joists, *a a a*. (2) DOUBLE OR FRAMED FLOORS.—In these floors the flooring boards, *a a* (fig. 496), run at right angles to, and are supported by, the "joists," *b b*; these in turn running at right angles to, and being supported by, the "binding joists," *c c*, which rest on the walls, *a d*, or upon "wall plates," *e e*. "Ceiling joists," *f f*, are notched into the under side of "binding joists," *c c*, and carry the laths, which support the plaster work of the ceiling. Where an open space—as for the hearth of a fire-place, or for the well-hole of a trap—*a a* (fig 497), is required in a floor, the flooring joists, *b b*—see *a a*, fig. 5—are carried by a "trimmer," *c c*, which is supported at the ends by "trimmer joists," *d d*, resting upon the walls, *e e*; *f f* are the ordinary joists, the trimmer and trimmer joists are heavier than the ordinary joists, *f f*. (3) DOUBLE FRAMED FLOORING.—In this form of floor the "flooring

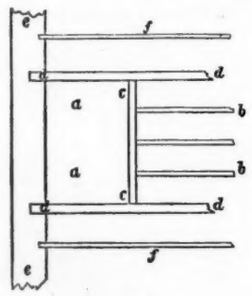

Fig. 497.

boards," *a a* (fig. 498), are carried by the ordinary "joists," *b b*; these are carried by the "binding" or "bridging" joists, *c c*; these being notched into the sides of "girders," *d d*, which rest upon "wall plates," *f f*, let into the wall, *e e*; or the ends of the girders rest upon the bottom plate of a cast-iron girder box let into the wall; or upon a flat bearing stone. The "ceiling joists" are at *g g*. The following are notes giving the dimensions or scantlings of parts of floors.

"Girders" *d d*, fig. 498, to be placed 10 ft. apart, 10′ span, 9″ × 7″; 12′ span, 10″ × 8; 14′ span, 11″ × 9″; 16′ span, 12″ × 10″; 18′ span, 12″ × 11″; 20′ span, 13″ × 11″; 24′ span, 15″ × 12″; 26′ span, 16″ × 12″; 28′ span, 16″ × 13″; 30′ span, 16″ × 14″. "Bending or bridging joists," *c c*, fig. 498, to be

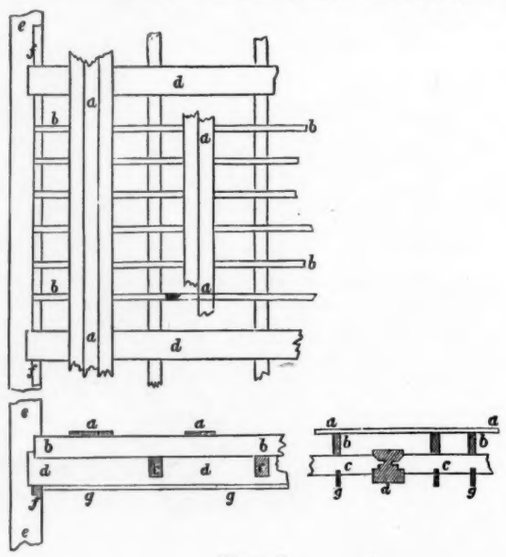

Fig. 498.

placed 4 ft. to 6 ft. apart, span 6′, 6″ × 4″; 8′, 7″ × 4½″; 10′, 8″ × 5″; 12′, 9″ × 5½″; 14′, 10″ × 6″; 16′, 11″ × 6½″; 20′, 13″ × 7½″. "Joists," *a a*, fig. 495, 12″ to 14″ from centre to centre; span or bearing 6 ft., 2″ × 6″; 8′, 2½″ × 7″; 10′, 2½ × 7½″; 12′, 2½″ × 8″; 14′, 2½″ × 9″; 20′, 3″ × 12″. "Ceiling joists," *g g*, fig. 498, 12″ apart, span or bearing 6 ft., 3½″ × 2″; 8′, 4″ × 2½″; 10′, 5″ × 2½″. "Pressure on floors." In calculating the pressure which floors have to sustain, allow per square foot 1¼ cwt. for floors of private dwellings, 1½ cwt. for public buildings, and 2¼ cwt. for warehouses.

Where girders (or tie-beams of a roof, see next paragraph) are to be lengthened, the methods of joining the two pieces are

various. In fig. 499, A shows that known as a "fish" joint; in this the two pieces as *a* and *b* are squared up at the ends *c*, to butt against each other firmly, and then secured by the fishing pieces of timber *d d*, *e e*, bolted to the two beams as shown. To make this a neater joint, the lower piece *e e* may be let in to the

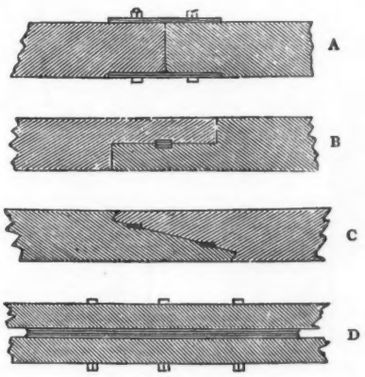

Fig. 499.

under side of beams; or the piece *e e* may be of wrought iron. The "half lap joint" is shown at B, a part as *a b c* being cut out at the end of the beam, to half its depth; the same being done at the other, and the two put together as shown. To add strength to this joint a timber "key" is put in at *d*, a groove being cut in both pieces to receive it. In C one of the

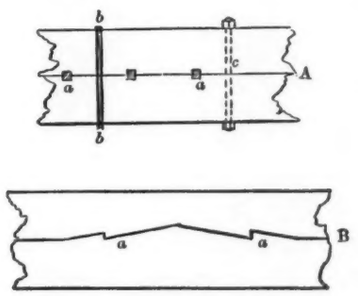

Fig. 500.

many forms of "scarf" joints is shown. This is a modification of the half lap joint in B, the face of the joint being oblique to the faces of beams: the ends *a* and *b* being at right angles to the face of joint; two keys are inserted in this. In D the "sandwich" or "flitch" beam is shown, by which the thickness of a beam is increased, and its strength also, by cutting it in

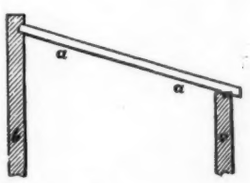

Fig. 501.

two, and inserting a "flitch" or plate *a a* between the two beams *b b*, *c c*, and securing the whole together by bolts and nuts. The depth of a beam is increased by various methods, two of which are shown in fig. 500, in A. Wood cogs or keys are used in B, the edges are scarfed as at *a a*, either straps as *b* in A, or bolts as *c*, secure the two together.

"ROOFS." The simplest form of roof is that known as the "lean-to," illustrated in fig. 501, in which a rafter or beam *a a* stretches from back wall *b* to front wall *c*, the "rafters" *a* being placed apart from 12 to 18 in. from centre to centre and carrying the boarding or battens upon which the slates or tiles or other form of roof covering rests. In fig. 502 a more complicated form of lean-to roof-truss is illustrated; in this a "tie-beam" *a* rests upon "wall plates" let into the wall *c c*, *d d* the "prin-

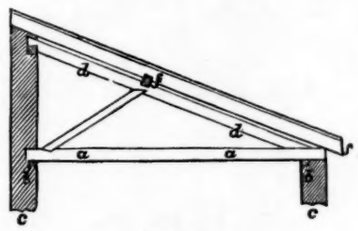

Fig. 502.

cipal rafter," *e* the "strut" or "brace," *f* the "purlin," *g g* the common rafter. In fig. 503 we give in *a* an elevation and in *b* a plan of this form of roof, *c* being in the plan the upper or "ridge," *d* the lower or "eaves" edge of the roof.

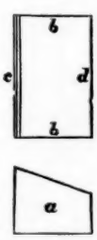

Fig. 503.

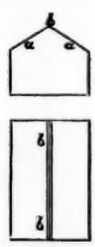

Fig. 504.

In what is called a "span" roof the rafters are inclined from the wall on either side, as *a a*, fig. 504, meeting at the apex or "ridge" *b b*. In fig. 12 *a a* is the end elevation, and *b b* plan of a span roof. In fig. 505 we give an illustration of a simple form of truss

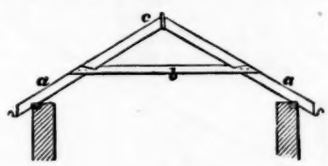

Fig. 505.

for a span roof, called a "collar beam" truss, from the use of the collar beam *a a*. A still simpler form is one in which this collar beam is dispensed with, and the rafters *a a* alone used, butting at their upper end against the two sides of the ridge-pole *c*. In

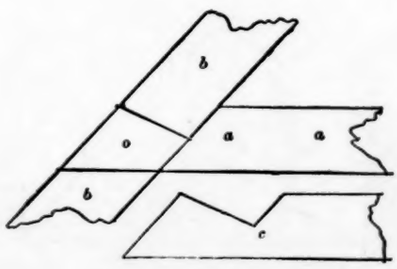

Fig. 506.

fig. 506 we give separately the form of joint used in a "curb" roof, where the collar beam *a* joins the rafter *b*, *c c* the end of the collar beam. A part of the same shape is cut out on the face of the rafter, but to half the depth of its thickness only, the end,

c c, of the collar beam being made half the thickness, so that when the two are put together, the surfaces of both are flush with each other. In fig. 507 we give an illustration of what is

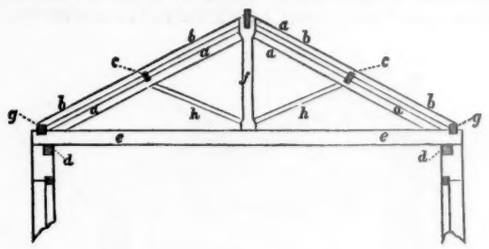

Fig. 507.

called a "king post" truss, adapted for a span roof. In this *a a* are the "principal rafters," which are placed from 7 to 8 ft. apart, butting at their lower ends, and jointed to the "tie beam" *e e*, and

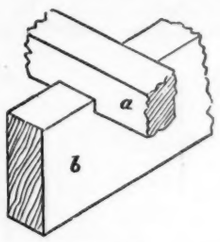

Fig. 508.

at their upper ends to the head of the king post *f*. They are supported at or about the middle of their length by the "struts" or "braces" *h h*. The tie beam *e e* rests on, and is notched into,

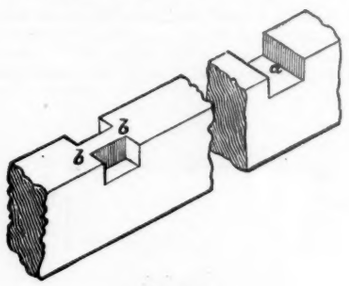

Fig. 509.

the "wall plates" *d d*, which are built into the wall and run along its whole length. Figs. 508, 509, and 510 illustrate various methods of joining wall plates with tie beams. In fig. 502 the

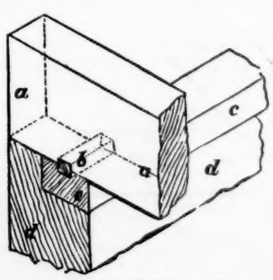

Fig. 510.

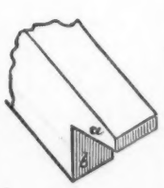

Fig. 511.

piece *a* is let into the piece *b* for a small depth, a piece being cut out of the face of the piece *b* across its face, the breadth being equal to thickness of piece *a*. In place of the notch being made in the upper face of *b* right across, as at *a* in fig. 509, a cross rib may be left, as shown at *b b* in same figure, the notch in the lower face of the part *a*, fig. 508, being cut in the depth equal to the depth of the rib *b b*.

Another method is illustrated in fig. 510. On the lower face

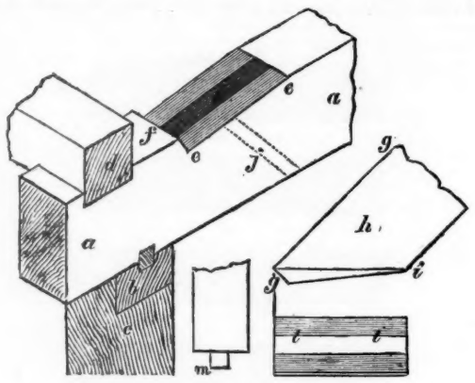

Fig. 512.

of the tie beam *a a*, a small notch is cut across it, to allow of a small wedge or key being driven tightly in. Half of the depth of this projects from the face of the tie beam, and is let into a groove cut on the upper face of the wall plate *c c*, which rests on

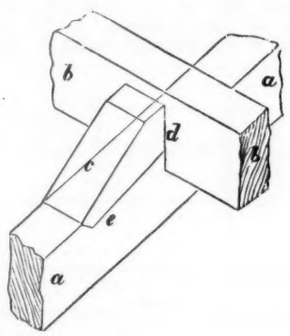

Fig. 513.

the wall *d d*. The tie beam *e e*, fig. 510, king post *f*, struts *h*, and principal rafters *a a* being placed at intervals along the wall, spaces are thus left between them; these spaces are filled up by the "common rafters" *b b*, at a higher level than the principal

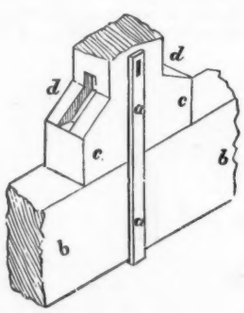

Fig. 514.

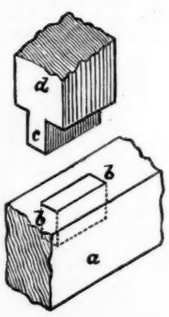

Fig. 515.

rafters *a a*, but parallel with them. The common rafters are supported in the middle of their length by horizontal timbers *c c*, called "purlins," these being notched into the upper side, or otherwise connected with the upper side of the principal rafters *a a*. The distance between the common rafters *b b* is usually from 12 to 14 in., but this may vary, as they are spaced to be at

equal distances between the principal rafters. The common rafters rest at their lower ends upon the "pole plates" *g g*, these being notched into the upper side of the tie beam *e e*, or as in fig. 511; this joint is called a "bird's mouth" joint. The upper ends butt against the head of the king post, or in some cases

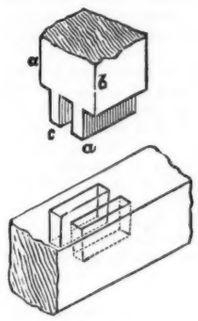

Fig. 516.

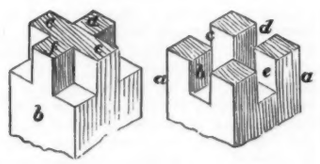

Fig. 517.

they rest upon the sides of the "ridge pole" which runs along from principal to principal, parallel with the wall plates *d* and pole plates *g*. The ridge pole is notched into the head of the king post, as shown. The members thus described and illustrated in fig. 507 make up what is called a "truss," although more correctly, perhaps, a truss is the triangular combination formed by the following members:—tie beam *e e*, king post *f*,

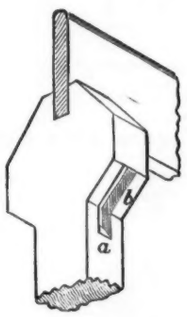

Fig. 518.

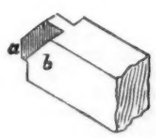

Fig. 519.

struts *h h*, and principal rafters *a a*, the other members being merely accessories. These, with the common rafters, are all at right angles with the wall, the ridge pole, wall plate, pole plate, and purlins being parallel thereto.

(94.) Having finished our description of the various parts constituting the truss of a king post roof, we now take up the consideration and illustration of the methods in which these various

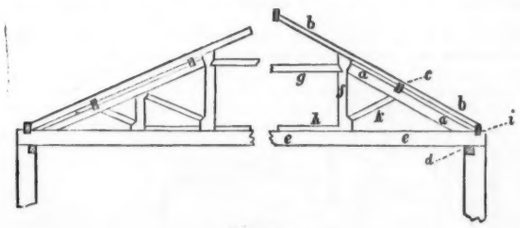

Fig. 520.

parts are joined or put together. A method of joining the principal rafter *a a* (see *a a*, fig. 507,) with the "tie beam" (see *e e*, fig. 507,) is shown in fig. 512, where *a a* is the tie beam, *b* the wall plate (see *d*, fig. 507), *c* the wall, *d* the pole plate (see *g*, fig. 507). In the face of the tie beam *a a* a sloping piece *e e* is cut, with a shoulder, *f*, the end *g* of the rafter *h* butts against *f*, the sloping surface *g i* bearing upon the sloping surface *e e* of the beam. The two are secured together by an iron strap running in the direction of the dotted lines *j*. In place of the surface *e e* in the tie beam being left plain, a mortice *k* is cut on its face, the end of the tie beam being finished off with a tenon *l l*, shown in edge view at *m*. Fig. 513 illustrates one method of joining the purlin (see *c c*, fig. 507) with the principal rafter, *a a*, same figure; *a a* the rafter,

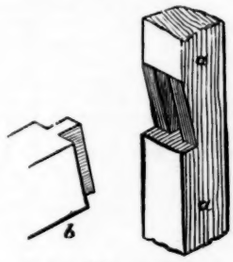

Fig. 521.

b the purlin crossing at right angles, and let partly into the face of the rafter in a notch cut across its face; *c* a block secured to the rafter by nails, the end *d* of which bears up against the face of purlin *b b*. The block *c* is generally let into the face of rafter by a sloping cut, as shown by the dotted line *e*. Fig. 514 illustrates the junction of foot of king post (see *f*, fig. 507) with tie beam (*e e* fig. 507), the two being often secured together by

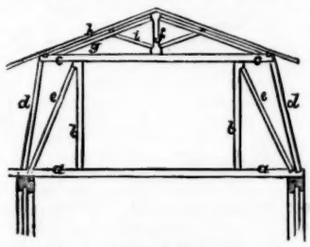

Fig. 522.

an iron strap *a* passing round the tie beam *a b*, and secured at the upper end by a bolt and nut, or by keys. The foot of the king post *c* is sometimes let into the tie beam by a tenon, the mortise being cut on face of the tie beam (see fig. 515); in this the hollow part *b b* let in *a* is the "mortise." A cut at the end of the piece *d* is called the tenon. Fig. 516 illustrates a

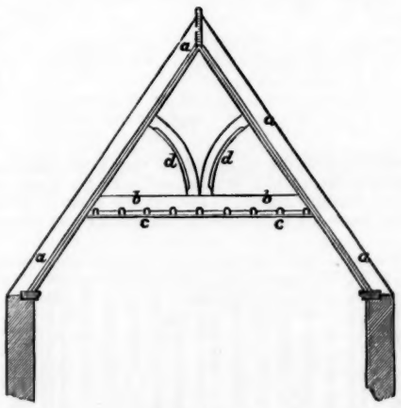

Fig. 523.

double mortise and tenon, two tenons as *a d* being cut on the end of the piece *a b*. Fig. 517 illustrates a method of joining two vertical pieces by a "cross joint," the projections *c d e f* in *b* going into the hollow parts *c d e f* in *a a*. The sloping surfaces *d d* are at right angles to the line of braces or struts *h h* (see fig. 181), and are usually provided with a mortise into which a tenon formed at foot of brace passes. The braces are often in addition secured to the king post by a combination or addition to the iron strap

a a going in the direction of the dotted line *e*. Fig. 518 shows the upper termination of king-post, *a* being the ridge-pole let into a groove made at top of post; fig. 519 shows the termination or upper part of brace or strut (*h h* fig. 507), letters being attached to the corresponding parts.

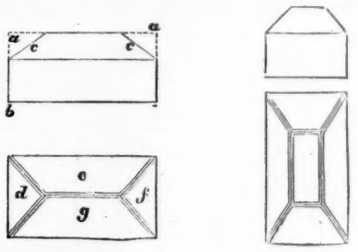

Fig. 524.

Fig. 525.

In fig. 520 we give the half elevation of two forms of queen post roofs, used for buildings of wider span than those in which king post trusses are used. In fig. 520 *a a* is the "principal rafter," *b b* the "common rafter," *c* the "purlin," *d* the "wall plate," *e e* the "tie-beam," *g* the "straining beam," *h* the "straining sill," *f* the "queen post." A corresponding

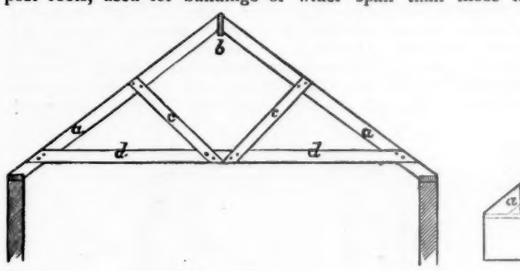

Fig. 526.

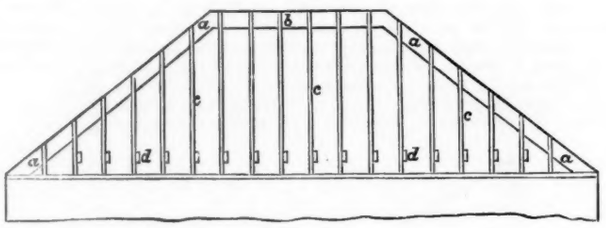

Fig. 527.

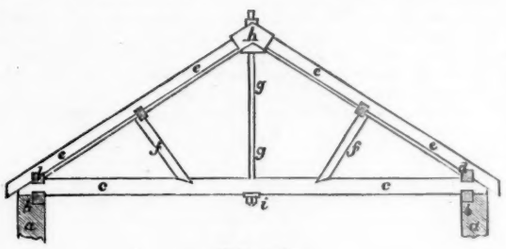

Fig. 528.

member to this is in the other side of the truss, thus leaving a space between them which may be utilized as a room or other apartment. In our diagram to the left the truss is shown with two queen posts. Fig. 521 illustrates the form of joint used in joining the straining beam *b* (see *g*, fig. 520) of a queen post roof with the queen post (see *f*, fig. 520), *a a*. *Dimensions of Parts of Roofs*, see note in p. 29 in the January number of the "Practical Magazine" for 1873. *Rules to find the Dimensions of Parts of Roofs*, see note, No. 12, p. 129, in the February number of the "Practical Magazine" for 1873. In fig. 522 we give an illustration of a "curb" or "mansard" roof truss—so called in the latter form from the name of its inventor. It is designed to be used in cases where an apartment is required in the roof with parallel sides in place of the sloping or curved sides of an attic apartment. In fig. 523 we give the truss of a Gothic or high pitched roof.

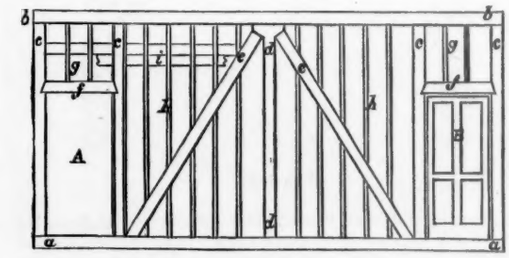

Fig. 529.

In the span roof the end of the building is formed with what is called a "gable," the angle of the sides of which are the same as the angle of side of roof. In fig. 504, *a a* shows the gable; the side elevation of a building with a gable therefore shows a rectangle, as *a a b b*, fig. 524; but where the ends of the roof are placed at an angle, as *c c*, giving in the plan four inclined sides, as *d e f g*, the roof is called a "hip" roof, the rafters at the angles being called jack or hip rafters, as *a a*, fig. 527. Where the roof terminates with a flat space, as *a*, fig. 525, in place of a point, as in the other forms of roofs illustrated, the roof is called a "pavilion" or "coach" roof. In fig. 526 we give a side elevation, and in fig. 527 an elevation, of a hipped roof.

Iron is sometimes used in the construction of roofs in conjunction with timber; of this we give, in fig. 528, an illustration in which the king post, in fig. 507, is replaced with a wrought iron rod, called a "king-bolt."

PARTITIONS.—In fig. 529 we illustrate a framed partition with a door space, as A, at both ends. B shows the panelled door filled in, *a a* the "sill," *b b* the "head," *c c* the posts, *d* the entire door, with braces or studs *e e*, *f f* the cross pieces, *g g h h* the filling-in pieces. The sides of the partition are provided with laths nailed on the timber in the direction shown at *i*, these supporting the plaster; or the sides may be covered by tongued and grooved boards. In fig. 530 we illustrate the cen-

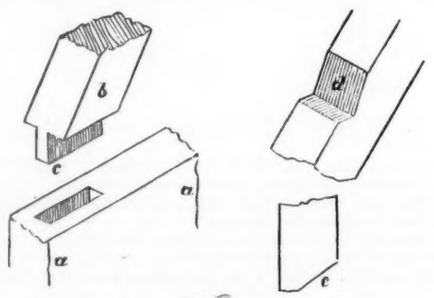

Fig. 531.

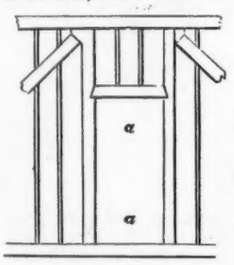

Fig. 530.

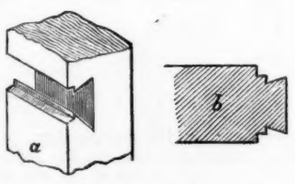

Fig. 532.

tral part of a partition in which the door space, *a a*, is in the centre of the partition. In fig. 531 we illustrate a method of joining the foot of the strut (*e e*, fig. 529), as *b*, with the sill *a a* (see fig. 529), by a tenon *c* going into a mortise, *a a*. The filling-in piece *h* (fig. 529) is joined at the foot with the strut *e e*, as shown at *d* and *e*, fig. 530. Fig. 532 is a joint which may be used for joining the cross-pieces *f f* (fig. 529) with posts *c c*, in place of the more simple joint there shown.

Chemistry applied to Arts and Manufactures; Engineering; Building, &c.

ABSTRACTS FROM FOREIGN PERIODICALS,

TRANSACTIONS OF SOCIETIES, ETC.

§ 1. *Acids, Alkalies, and Salts.*

ACETIC Acid from Wood Distillation.—MOREAU patents the use of peculiar furnaces, retorts, and condensing arrangements, and the employment of the following method. The crude liquor is saturated with lime and separated from light and heavy tars, then treated with sulphate of soda equivalent to the carbonate of lime. The precipitate is pressed in bags, and the liquors treated with a slight excess of formio-acetate of lead (mixture of formiate and acetate). Aniline, phenols and most of the tarry matters are thus precipitated, and in the magma is found the pyrogallic phenol present in those tars obtained from wood of the *Cupuliferæ*. The clarified liquor is then fractionally distilled so as to obtain acetone, methylic alcohol, &c.: the yield of these is considerably increased if the wood employed be soaked in a weak solution of alkaline carbonate before distillation. The liquor is then evaporated to crystallization, whereby acetate of soda is obtained; the mother liquor of this gives a second crop of needle-like crystals of aceto-propionate of soda on evaporation. The first crystals give a good crude acetic acid on distillation with sulphuric acid, but containing about one-tenth of formic acid; the second yields a mixture of acetic and propionic acids, and the final mother liquors acids higher in the acetic homologous series: these acids can, according to the author, be converted into formic acid and their lower homologues (and therefore ultimately into formic and acetic acids) by treatment with metallic dioxides, and notably by red lead, Pb_3O_4, whereby formate of lead is produced, and the next lower acid in the series: thus valerianic acid gives lead formate and butyric acid; this treated again in the same way gives propionic acid and lead formate, and the propionic acid again gives acetic acid.

The acetic acid thus obtained and purified by fractional distillation, &c., is dehydrated by sulphate of lime and converted into glacial acid; similarly formic acid is prepared from the lead salt by distillating with sulphuric acid, and dehydration by boiling with sulphate of lime. *Bulletin Soc. Chim. Paris, xxii.* 526.

Purification of Oxalic Acid.—F. STOLBE recommends to dissolve the acid in a sufficient quantity of boiling hydrochloric acid solution (10 to 15 per cent. of real acid) and then allow to crystallize: the crystals are well drained and washed until they retain but little hydrochloric acid, and are then recrystallized from water, the liquor being stirred during cooling so as to form small crystals. Acid thus prepared leaves no residue on ignition. The mother liquors are saturated with ammonia, and the oxalate of ammonia formed crystallized out. *Chem. Soc. Journal, xii.* 1084, *from Chem. Cent.* 1874, 119.

Nitric Acid.—E. C. PRENTICE patents the following improvements in the manufacture of nitric acid. (1) Mixing with the nitrate employed chlorate of potash; permanganates or manganates of the alkalies or of the alkaline earths, or the peroxides; chromic acid, the chromates and the bichromates of the alkalies and of the alkaline earths; or of such metallic oxides and compounds as shall by the action of sulphuric acid and by the presence of the lower oxides of nitrogen, be capable of elevating the same from a lower to a higher degree of oxidation: (2) instead of adding to the nitrates either of soda, potash, or lime, the whole or a portion of the oxidizing agents, such oxidizing agents are added to the sulphuric acid to be employed for effecting the decomposition of the nitrates: (3) employing oxygen in a pure form, such as that obtained by the heating of peroxide of manganese and chlorate of potash in admixture with the products which are evolved in the production of the nitric acid from the nitrates: (4) employing an intermediate vessel containing sulphuric acid, in conjunction with any of the before-mentioned oxidizing agents, so as to effect the conversion of the lower oxides of nitrogen in the higher: (5) any of the before-mentioned oxidizing agents in conjunction with nitric acid, so as to convert the same into the higher oxides or into nitric acid: (6) the treatment by the admixture of any of the before-mentioned oxidizing agents, of a mixture of nitric acid and of sulphuric acid resulting from the production of gun cotton or from other sources, such acids containing organic or other matters or compounds as cause the decomposition of the nitric acid upon the application of heat.

Tartaric Acid.—VILLARD extracts the tartar from the refuse of grapes by boiling with water and methodically lixiviating with boiling water, whereby saturated tartar solutions are obtained containing about six per cent. of bitartrate of potass; the hot solutions are then rapidly cooled in a refrigerator, exposing a large surface to the action of cold water; the mother liquors of the crystals deposited are used over again, as they retain somewhat more than 0·5 per cent. of bitartrate, this salt being soluble in 184 parts of cold and about 15 of boiling water. *Bulletin Soc. Chim. Paris, xxii.* 427.

Manufacture of Chlorine by the Deacon Process.—J. PATTINSON states that this process is in operation in four of the manufactories in the Newcastle district. The conditions necessary for the uniform and successful working of this process are not yet fully known. The produce of bleaching powder, for instance, from one decomposer varies as much as from 10 tons to 36 tons per week, and the cause of this variation remains to be discovered, excepting that it is known that irregularity of temperature has something to do with it. The greatest difficulty to contend with is, however, that of keeping the decomposer free from leakages and the consequent production of weak bleaching powder. The gases being drawn through the apparatus by means of a pump, any fissures in the decomposer cause carbonic acid to be drawn in from the surrounding flues and conveyed to the lime chambers. Still, in spite of these drawbacks, the usual yield of bleaching powder of good strength is about one ton for every two tons of salt decomposed, and this result is obtained when the pan acid alone is used. The cost for labour, fuel, &c. is very small. The process, therefore, even in its present state, may be said to be a very successful one, and when experience and research shall have more clearly indicated the conditions requisite for uniform working, it will probably become the chief process followed in our bleaching powder manufactories.—*Presidential Address to the Newcastle-on-Tyne Chemical Society, Oct.* 29, 1874.

Weldon's Chlorine Process.—In giving an account of Weldon's regenerating chlorine process at the last meeting of German Naturalists in Breslau, Lunge stated that of the 85,000 tons of bleaching powder produced last year in England, 60,000 tons, that is, nearly two-thirds of the total amount, were manufactured by Weldon's method.

[Our magazine has already some time ago (March, 1872) pointed out the superiority of the regenerating process over all other rival methods. *R. G.*]

Sulphur in Sicily.—QUESNEVILLE states that but little sulphur is found as a deposit from recent volcanic eruptions, the majority of the supply being obtained from deep-lying beds in which the sulphur exists along with sedimentary rocks; from these deposits the sulphur is obtained by a very rough process, consisting virtually of a simple fusion where the fuel used is the sulphur itself; hence ore containing from 15 to 40 per cent. of sulphur only yields 10 to 25; great damage is also done to vegetation and to the health of the workmen by the sulphurous acid evolved during the process. The actual yield of the Sicilian mines (without including the sulphur wasted) is about 180,000 tons per annum; the sulphur mines of the Romagna only yield 120,000 quintals of 100 kilogs. (equal to about 12,000 tons). Of the sulphur exported from Sicily, England takes about 20 per cent., France 10, and America 25 per cent. The author calculates that the Sicilian mines will be wholly exhausted in from fifty to sixty years. *Moniteur Scientifique, Sept.* 1874.

Preparation of Iodine.—O. THIBAULT prepares iodine from the natural phosphates of Lot and Tarn-et-Garonne in the following way. The mixer is made of cast iron, into which

the powdered phosphate and sulphuric acid are continuously introduced, so as to form a thick mass, which is collected in chambers built of brickwork (acid at 53° B. is used); the vapours given off from the mass are aspirated up a sheet-iron tower filled with coke, down which a stream of water runs, the water being used over again several times successively; finally, a liquor containing much iodide of iron results, the metallic sides of the tower being attacked. From this liquor iodide of copper can be formed, whence the iodine is extracted by distillation with sulphuric acid. All the iodine evolved in the gaseous condition is thus collected, although some still remains in the superphosphate. *Comptes Rendus, lxxix.* 384.

THIERCELIN took out in 1873 a patent for the extraction of iodine by a similar process; he describes his process as follows: A vertical agitator, consisting of a cylindrical axle with winged arms, rotates in a tub; this tub is covered over and communicates with a side vessel (condensing chamber), and subsequently with two earthenware jars containing solution of potassium sulphite. A tolerably powerful aspirating arrangement is applied to the second of these jars, so that any vapour evolved in the tub is ultimately condensed either in the chamber or in the jars, without passing outwards and being lost. The phosphate and acid are introduced into the tub in the required proportions, so that no air is drawn in at the time; the agitator is then kept in motion for half an hour, so that a thoroughly homogeneous mass is obtained, whilst the small amount of iodine imprisoned in the soft mass has every facility for escaping. In this way, by successive improvements in the mode of manipulation, 100, 150, and finally more than 250 grammes of iodine per ton of materials has been actually obtained, the iodine present in the crude phosphate amounting to about 500 grammes per ton. *Bulletin Soc. Chim. Paris, xxii.* 435.

Sulphovinates.—T. L. PHIPSON prepares sulphovinate of lime by adding to alcohol its own volume of sulphuric acid, and heating the mixture in the water-bath for eight to ten hours. After cooling, the liquid is gradually poured, with continual stirring, into twenty times its bulk of cold distilled water, so as to avoid any considerable rise of temperature. Powdered chalk is then added, in small quantities at a time, until effervescence ceases. The liquid is then filtered from the sulphate of lime, digested half an hour with a little chalk, filtered warm, and finally evaporated at a heat not exceeding 100°, until a permanent solid layer forms on the surface. The liquid is then set aside to crystallize for twenty-four hours. The mother liquor will yield another crop of crystals after evaporation over sulphuric acid. The sulphovinate of barium may be prepared in the same way, substituting carbonate of barium for chalk. From either of these salts sulphovinate of sodium or potassium may be prepared by double decomposition. *Chemical News, xxx.* 221.

Manufacture of Sulpho-Carbonates.—P. THENARD prepares sulpho-carbonate of barium by agitating together sulphide of carbon and solution of sulphide of barium, when the salt in question is deposited as a dense canary-yellow crystalline powder. For manufacture on the large scale, the mother liquor from one operation is treated with a hot solution of sulphide of barium, until the temperature rises to 15° or 20° above that of the atmosphere. Rather less than the equivalent quantity of bisulphide of carbon is then added, and the whole agitated for five to six hours, when the smell of the bisulphide is no longer perceptible; the whole is then run into a settler, and after twenty-four hours the supernatant liquor is run off, and again treated with bisulphide in slight excess. Agitation is kept up for twelve to fifteen hours, after which the aqueous liquor is run off, and hot barium sulphide added to it as at first. This warm liquor is then poured back on to the mixture of solid sulpho-carbonate, and fluid bisulphide left at the bottom of the tank used in the previous part of the process, and the whole series of operations repeated. From the barium sulpho-carbonate other salts can be readily prepared by double decomposition. *Comptes rendus, No.* 12, 1874.

Manufacture of Phosphates and Phosphorus.—A. S. HUNTER patents the following processes for treating bones, horn piths, phosphates, &c.:—1. Recovering hydrochloric acid from solution containing phosphates or phosphoric acid by evaporation and condensation. 2. The use of retorts provided with valves, whereby continuous distillation of phosphorus, charging and discharging, may be carried on, without permitting access of air to the interior of the retorts when at work. 3. Causing volatilized phosphoric acid to come in intimate contact with carbon at a temperature sufficiently high to deoxidize the acid. 4. The use of gelatinous silica for the purposes described. 5. The production of gelatinous silica and phosphate of soda or potash from silicates of soda or potash by precipitation by means of phosphoric acid. 6. Separating phosphorus from phosphate of soda or potash by distilling the said phosphates mixed with silica, and recovering silicate of soda or potash available for producing gelatinous silica. 7. A combined process whereby the constituents of bones or horn piths may be obtained as glue or gelatine fertilizers, sulphate of lime, and phosphorus. 8. A combined process for decomposing phosphate of lime, soda, or potash, and for the subsequent recovery of the soda or potash. 9. The employment of precipitated tribasic phosphate of lime for the production of phosphorus by distillation with silica. 10. The employment of self-acting valves between the distilling retorts and the condensers to prevent back pressure therefrom to the retorts. 11. The employment of self-acting valves between the several retorts to prevent back pressure from one retort to the other, and to enable one retort of a series to be opened at pleasure, without back flow from the others.

Permanganates of the Alkaline Earths.—TESSIÉ DE MOTAY prepares manganate of barium, either by precipitating an aqueous solution of potassium or sodium manganate with baryta, or by heating in a stream of air hydrate of barium and binoxide of manganese. If carbonic or sulphuric acid be passed over the product, permanganic acid is set free, and barium carbonate or sulphate formed; hence the permanganate of lime, magnesia, &c., can be readily obtained. *Dingler's Polytech. Journal, ccxi.* 403.

FLEISCHER prepares a basic manganate of barium by heating manganate or permanganate of barium with hydrate of barium. A bluish green mass thus results, which may be used as a pigment; the shade depends on the amount of hydrate added. *Ibid. ccxi.* 320.

§ 2. *Metallurgy.*

Relative influence of Manganese and Phosphorus on Steel.—GRÜNER has shown that the presence of phosphorus prevents, to a great extent, the extension of steel by traction: thus the following numbers are given:—

Character of Steel.	Lengthening before Rupture.
Good, retaining 0·45 to 0·60 per cent. of carbon, but free from phosphorus.	9 to 10 per cent.
Made by the Heaton process, and retaining phosphorus 0·25 to 0·50 per cent.	3 to 4 „
Slightly carbonized Hyange steel retaining 0·25 to 0·50 per cent. of phosphorus.	barely 3 „

WEDDING states that at Königshütte, Silesia, a pig containing 0·49 per cent. of phosphorus gave in the converter a steel which could be laminated, forged, and welded, but was too fragile for rails, &c.

Manganese, on the other hand, possesses the property of rendering steel very malleable and capable of welding, apparently by its preventing the formation of oxide of iron, which prevents welding; hence sulphurized, phosphorized, and carbonized steel can readily be forged, provided they contain enough manganese. The fact that manganese renders cast metal fragile in the cold has led to the idea that it had the same effect on steel; this is, however, an entire mistake; thus the following analyses of common metal and rail steels are given:—

Cannon Steel.

	Terre Noire.	Barroin.
Silicon	6·02	0·05
Sulphur	2·0	3·0
Phosphorus	0·021	0·042
Manganese	0·24	0·24
Carbon	0·29	0·31

Rail Steel.

	Manganese.
From Creusot	3·55 per cent.
„ Petit Gaudin	0·56 „
„ Terre Noire	0·86 „
„ Seraing	0·65 „

In fine, the amount of carbon must be diminished as much as possible in phosphorized steels; manganese, on the other hand, will permit steel to be laminated that would otherwise be entirely unfit for this operation through the presence of metalloids. *Bulletin Soc. Chim. Paris, xxii.* 423. *From Revue Universelle des Mines, xxxv.* 629.

Direct Preparation of Iron from its Ores.—J. PATTINSON states that the process of Blair (*vide* "Practical Magazine," No. 21, p. 226) is carried out in the following way:—

A mixture of ore and charcoal is heated in vertical tubes 40 ft. in height and 3 ft. in diameter. The upper part of this tube is heated externally by gas generated in gas producers, and internally by the combustion of the carbonic oxide arising from the action of the charcoal on the iron ore, whilst the lower part is cooled by encasing it in a water jacket. The iron which is reduced to the metallic state in the upper part of the tube is thus cooled down in an atmosphere of carbonic oxide in the lower part, so that when it reaches the bottom of the tube it may be removed in the air without fear of re-oxidation. The materials are fed in at the top and withdrawn at the bottom continuously. The metallic sponge thus produced is then pressed into lumps by hydraulic pressure, and used for the making of steel in the Siemens-Martin process instead of wrought-iron. The process has been at work for some time at the Glenwood Iron Works, Pittsburgh, and Blair claims that there is a very considerable saving in the cost of production of steel from his iron sponge as compared with the use of wrought-iron. With very rich iron ores processes of this kind may probably be economical if a well-planned apparatus is used, but it is very doubtful if this would be the case with poor and siliceous ores, owing to the waste of iron which would occur in smelting out the earthy matters. The process is not yet removed from the region of experiment, and the progress it makes will be watched with interest by all iron and steel makers. *Presidential Address to the Newcastle-on-Tyne Chemical Society, Oct. 29th,* 1874.

Silicon in Iron.—TROOST and HAUTEFEUILLE find that when pig iron containing silicon is oxidized by a flame of oxygen and coal gas the oxidation takes place tranquilly, whereas non-siliceous pig gives off abundance of sparks: the latter dissolves much carbon oxide, and hydrogen, which causes spitting in the cooler portions; this is not the case with highly siliceous pig. A fused manganiferous pig iron introduced into fused siliceous pig gives rise to bright sparks. Molten cast iron acts slowly on porcelain, taking up silicon and losing carbon: thus the following numbers were obtained:—

	Carbon.	Silicon.
Original cast iron	5·32	0·21
After 48 hours' heating in a porcelain vessel	5·20	0·87
After 24 hours' heating in gaize.	3·90	1·07

So also with steel; thus—

Cast steel	1·54	0·10
After 24 hours' fusion in a Hessian crucible	0·74	0·26
After 24 hours' fusion in gaize	0·70	0·80

Bulletin Soc. Chim. Paris, xxii. 469. *From Comptes rendus, lxxviii.* 1276 *and* 1438.

New mode of preparing Steels, &c.—N. W. WHEELER patents the following process. Granulated ore is showered down through a column of flame and carbon gases confined in a vertical shaft, so that the ore is heated to incandescence while falling through the carbon gases. Carbon steel is produced by showering the ore through the column of flame and carbon gas into a bath of fused carbonated iron. Chrome steel is made by showering the ores of iron and chrome proportionately mixed through the double column mentioned into a bath of molten metal. The apparatus consists of a vertical shaft rising from a reverberatory furnace provided with a receiving hearth under the shaft and a balling hearth under the arch of the furnace, with a door at each hearth and a gas and an air inlet at one end. Holes are formed in the sides of the shaft at about half its height to admit air for the combustion of the gas column. Near the top of the shaft are holes, through which the ore enters in a shower from a series of hoppers, and a rotating radially chambered drum forming the ore-feeding apparatus; a separate but like apparatus feeds the flux at a different point.

Tungsten and Chromium Steels.—WOODS and CLARK add to iron and steel from 1 to 5 per cent. of an alloy composed of—

Tungsten	10 parts.
Chromium	90 „

Hereby great hardness and power of resisting rust are obtained. The following mixture gives an alloy of a silver-white colour, capable of taking a high polish, and applicable as speculum metal:—

Steel	67 parts.
Tungsten chromium alloy containing 5 per cent. tungsten and 95 per cent. chromium	33 „
	100

Dingler's Polytech. Journal, ccxi. 485.

Spiegeleisen.—The following analyses of spiegeleisen represent the character of the best kinds brought to New York in 1868, 1869, and 1873:—

	1868		1869		1873	
Iron	85·570	84·455	84·122	84·869	—	—
Manganese	9·142	10·625	10·568	10·223	11·130	10·22
Copper	0·032	0·034	0·036	0·031	·279	·20
Nickel & cobalt	0·005	0·005	0·004	0·002	—	—
Silicon	0·068	0·368	0·286	0·384	—	—
Carbon	5·048	4·304	4·907	4·461	—	—
Sulphur	—	0·002	—	0·001	—	—
Phosphorus	0·037	0·044	0·014	0·027	0·039	0·06
Aluminium	0·082	0·045	0·032	0·012	—	—
Calcium	0·015	0·016	0·021	—	—	—

Journal of the Chem. Soc., xii. 1118, *from Dingler's Polytech Journal, ccxii.* 350.

Nickelization versus Gilding of Iron.—BÖTTGER states that gilding is less efficacious for protecting iron against rust than nickel; the gold film being very porous, whilst that of the nickel is dense. *Meeting of Germ. Naturalists, Breslau,* 1874.

White Metal.—DELATOT prepares a composition consisting of the following ingredients:—

Pure red copper	80 parts.
Oxide of manganese	2 „
Zinc	18 „
Phosphate of lime	1 „

This is then fused, whereby a product is formed capable of replacing all the white metallic combinations now in use. To the melted copper is added the oxide of manganese in very small quantities at a time. When the oxide of manganese is dissolved in the copper, the phosphate of lime is then added similarly in small quantities. After this reduction has lasted about half an hour, the scoria which floats on the metallic bath must be skimmed off, and then the zinc added, about ten minutes before running the metal. This will give a white hard metal, equal to gun metal in tenacity and resistance, and superior in obviating friction, and can be made at a less cost. In order to accelerate the fusion of the oxide of manganese a flux may be used of the following composition: Half a part of fluoride of calcium, half a part of borate of soda, and one part of charcoal. The above proportions of the white metal may be varied considerably, according to the quality of metal required. *Iron, No.* 100, *p.* 751.

Colouring Sheet Zinc.—PUSCHER employs acetate of lead for this purpose. On applying this substance, mixed with a minium preparation, a reddish brown tinge is obtained. The cupola of the synagogue at Nuremberg was thus coloured, as an experiment, over a year ago, and, to all appearance, is yet unaffected by the weather. By adding other bases, lighter or darker tints of grey and yellow may be obtained, giving the zinc work the appearance of carved stone. With a solution of chlorate of copper, the preparation turns the sheets of zinc black. *Iron, No.* 99, *p.* 717.

Chlorine in Metals.—C. KUNZEL states that certain metals can retain small quantities of chlorine which exerts a great influence on the properties of the metal; thus cupriferous nickel, prepared from a mixture of oxychloride of copper and hydrate of nickel, by precipitating a mixture of the chlorides of the two metals by lime and reducing the mixture by charcoal dust, retains sufficient chlorine to render it unsuitable for the manufacture of argentan by alloying with zinc; the author has found from 0·13 to 0·18 per cent. of chlorine in the alloy. Similarly, soft iron obtained from waste tin-plate by treatment with hydrochloric acid to dissolve off tin was found, although free from tin, to retain much chloride of iron, and evolved many sparks on hammering. For this same reason this iron answers well for puddling when introduced in quantities of 20 to 40 kilogs. at the moment when the "boiling" is most marked; phosphorus especially is thus removed by the action of the chlorine; with pig not containing phosphorus, on the other hand, the introduction of the chlorine into the mass damages the quality, the rolled iron ultimately produced retaining a little chlorine.

Again, a specimen of zinc obtained from the residues of zincing iron was found to be wholly unsuitable for rolling, and this was traced to the presence of from 0·2 to 0·3 per cent. of chlorine. *Bulletin Soc. Chim. Paris, xxii.* 422, *from Revue Universelle des Mines, xxxv.* 638.

Extraction of Copper from Poor Ores.—LEITHNER roasts the burnt pyrites found in the vitriol works, and then

heats with lime so as to give an iron ore containing 40 to 50 per cent. of iron; by the cementation process the copper is left in the slag. From 31,500 cwt. of ore 20,618 cwt. of oil of vitriol, 15,057 of iron for precipitation, and 315 cwt. of copper can be produced. *Chem. Soc. Journal, xii.* 1117, *from Dingler's Polytech. Journal, ccxi.* 349.

Separation of Silver from Burnt Pyrites.—J. PATTINSON states that the following process introduced by Gibb is completely successful; the cupreous pyrites are burnt for vitriol making, and the residue treated by Henderson's process (*vide* "Practical Magazine," May, 1873) for the extraction of the copper (heating with common salt to convert the copper present into chloride of copper). The silver is thus converted into chloride of silver and retained in the solution obtained by lixiviating the product with water by the excess of salt present. Gibb's method of separating the silver differs from that of Claudet ("Practical Magazine," *ibid.* and June, 1874, viz. precipitation as iodide of silver), in being based on the fact that when sulphuretted hydrogen diluted with common air is passed through a cupreous solution containing small quantities of silver, the silver is precipitated first, or at any rate that the most of the silver is precipitated as sulphide with a relatively small proportion of the copper. Sulphuretted hydrogen is generated by the action of dilute hydrochloric acid on soda waste, and drawn from the generating tanks, in admixture with common air, by a blowing engine which forces the mixture into the copper solutions. This is continued until about 6 per cent. of the copper in the liquors is precipitated, when it is found that the solutions which usually contain about 20 ozs. of silver per ton of copper before the action of sulphuretted hydrogen, are reduced to 3 oz. of silver per ton of copper on the average, and the mixed sulphides of copper and silver precipitated contain about 200 oz. of silver per ton of copper. The sulphide precipitate is washed and calcined at a low temperature. The silver becomes soluble in common salt solution, the precipitate, although washed, retaining chlorides sufficient to change the sulphide of silver into chloride during the calcination. A part of the sulphide of copper is changed to sulphate, and the remainder to oxide, by the calcination. The sulphate of copper is washed out with water in wooden tubs, and the chloride of silver, with some chloride of copper, is subsequently dissolved out by strong hot brine. The sulphate of copper solution first washed out contains only about one ounce, and the oxide of copper remaining after dissolving out the chloride of silver, 4 or 5 ozs. of silver per ton of copper. The former is precipitated with the ordinary copper liquors in the usual manner, and the latter smelted with the ordinary copper precipitate. The solution of chlorides of silver and copper in common salt is mixed with milk of lime to decompose the metallic chlorides, and the chloride of calcium produced is washed from the precipitated oxides. These oxides are treated with dilute sulphuric acid, which dissolves the oxide of copper leaving the silver. The residue, which contains about 10 per cent. of silver as chloride with sulphates of lime and lead, after the sulphate of copper has been washed from it, is dried and sold to silver smelters. Fully half an ounce of silver per ton of burnt ore is recovered, and although the operations just described appear somewhat numerous and troublesome, yet the total cost of recovery is not more than 1*s.* 6*d.* per oz. of silver. During the first nine months of the year 1874 an amount of residue containing 16,000 oz. of silver has been extracted at the Bede Metal Works by this process. *Presidential Address to the Newcastle-on-Tyne Chemical Society, Oct.* 29, 1874.

Extraction of Silver from Argentiferous Lead.—J. A. CIOGNANI patents the following process, divided into seven stages:—(1) Melting the lead in pots and skimming; (2) introducing zinc into the pot and skimming off the argentiferous zinc; (3) heating the desilverized lead in a reverberatory furnace, to remove the remaining zinc; (4) roasting the zinc scum on the inclined sole of a furnace, to allow some of the lead to run out; (5) treating the zinc scum to transfer its silver to a comparatively small quantity of lead; (6) cupelling the rich lead of the last stage; (7) treating the slag produced in stage 5.

Desilverization of Lead by Steam.—The following table gives the cost in francs of this process, as deduced from an average of 5,398 tons, containing 123 grammes (4 oz.) of silver per ton (*vide* "Practical Magazine," November, 1874).

	Crystallizing apparatus	Purifying.	Scumming.	Reduction of oxide.
Wages . .	7·45	0·25	1·63	1·36
Coal . .	6·95	0·54	1·56	2·75
Iron . .	1·64	—	—	—
Wear and tear	0·81	0·14	0·21	0·53
Total .	16·85	0·93	3·40	4·64

Making a total cost of 25·82 francs. By Pattinson's process, on the other hand, the cost is 46·54 francs per ton of lead refining. The losses of silver and lead in the two processes are:—

	Lead.	Silver.
Pattinson's process . .	3 per cent.	1·5 per cent.
Steam process . . .	2·1 „	1·5 „

Whilst the steam process only causes the production of 200 to 220 kilogs. of oxide per ton, Pattinson's process forms 400 to 550 kilogs.; a shorter time is requisite, and therefore there is less cost for wages. *Dingler's Polytech. Journal, ccxi.* 352.

French Exports and Imports of Iron in 1874.—The imports of iron and steel into France during the first ten months of the year 1874, showed an increase of 6,600 tons over those of the corresponding period of 1873, chiefly in wrought irons, cast iron and steel having remained almost stationary.

The exports during the same period showed a falling off of 24,000 tons, or 19 per cent., as compared with 1873. This position of affairs is sufficiently grave to merit the careful consideration of all interested in the trade; it readily explains the difficulties which oppose any reduction in existing market prices.

The imports of iron ore during the aforesaid ten months amounted to 706,863 tons, or about 3 per cent. more than those of 1873. Ores from the Isle of Elba have made a remarkable advance.

The works at Creusot have received from Russia an order for 30,000 tons of steel rails, to be delivered at Cronstadt, at 288 francs per ton. This and other large orders from French and foreign railways may be expected to give a new impetus to the importation of ore from Algeria. It must not be forgotten that the average prices of Mokta ore have fallen considerably since the mining operations there have undergone extension, and that consequently the quantities imported as compared with the demand have acquired increased importance.

Exports of French ores during the first ten months of 1874 figure at 186,000 tons against 303,000 tons during the same period of the previous year. This would be satisfactory, were it not, at the same time, an indication of general slackness in the trade everywhere.

The arrivals of pig and wrought iron in Paris show a steady increase. Those of pig iron during the month of October last reached a total of 5,076 tons—the highest ever yet attained. There is, however, great stagnation in the trade. *Revue Industrielle, 2nd Dec.* 1874, *from Bulletin du Comité des Forges.*

§ 3. *Dyeing, Calico Printing, Bleaching, Tanning, Pigments, and allied subjects.*

Preparations of Alizarin.—C. LIEBERMANN finds that by heating beta-benzoyl benzoic acid with fuming sulphuric acid, there is produced anthraquinone-disulphonic acid identical with that obtained from anthracene as starting point, and capable of forming ordinary alizarin by treatment with alkalies; although this method of producing alizarin is at present too costly for use, yet it is by no means impossible that it may hereafter prove of commercial value, should any cheaper methods be discovered of producing benzyl chloride, benzyl toluene and benzoyl benzoic acid. *Berichte der Deut. Chem. Ges. vii.* 805.

Manufacture of Purpurine.—F. DE LALANDE announces the discovery of the preparation of purpurine by the artificial oxidation of alizarin by means of a mixture of sulphuric acid and arsenic anhydride or manganese dioxide. *Berichte Deut. Chem. Ges. vii.* 1545.

The inventor employs the following mixture:—

Dried and powdered alizarin	1 part
Strong sulphuric acid	8 to 10 „
Dried arsenic acid } Or, manganese dioxide . . . }	1 „

The temperature is gradually raised up to 150° to 160° until a drop of the mixture poured into a dilute solution of caustic soda produces the coloration of purpurine; the whole is then poured into water and the precipitate well washed with cold water; finally the precipitate is dissolved in a cold saturated solution of alum, allowed to settle, and then the purpurine is thrown down from the solution obtained by means of an acid. For further purification the alum treatment may be repeated, and the resulting purpurine crystallized from superheated water.

The yield of purpurine is considerable, the chief loss being due to the formation of a colouring matter soluble in water with a brown-yellow tint, and in alkalies with a red colour; this product is chiefly formed when arsenic acid is used; it tints alumina mordants of a dirty yellow orange. The purpurine formed in this

way appears to be identical with the natural product; it has the same percentage composition (C_{14} H_8 O_4) and the same solubility in various media, and its solutions dye the same shades possessed of the same solidity in variously mordanted fabrics. *Comptes rendus, lxxix.* 669.

Indigo.—C. W. SMITH treats the plants with carbonate of soda ley of ½° to 1° B. whereby chlorophyll is dissolved out; the residue is then boiled with milk of lime of from 2° to 5° B. whereby the indigo is dissolved out, stannous oxide or chloride or both being added, to cause the reduction of the indigo. *Dingler's Polytech. Journal, ccxi.* 403.

Croissant and Bretonniere's Dyes.—The manufactory of these patent colours at Göttingen has been suppressed by the police authorities as a nuisance, apparently owing to the large production of sulphuretted hydrogen during the process of manufacture. *Reimann's Färberzeitung, No.* 38, 1874.

The chemical section of the Société Industrielle de Mulhouse reports that these colours furnish very fast shades both for dyeing and printing; the tints are not brilliant, but sufficiently so to render the colours suitable for simple but very fast styles. *Ibid.*

Printing Woollen Goods.—The following receipts are given for printing various colours on woollens:—

Scarlet.

Starch	4½ lbs.
Cochineal liquor at 6° B.	18 litres.

Mix boiling, and then add—

Tin crystals	9 oz.
Oxalic acid	1½ lb.
Tin liquor at 6° B.	2½ lbs.
Fustic liquor at 15° B.	1½ lb.
Oil of turpentine	½ litre.

Black.

Extract of indigo	½ lb.
Crystallized chloride of ammonium	¾ lb.
Roasted starch	16 lb.
Extract of logwood at 7° B.	16 litres.

Boil up and agitate until nearly cold, and then add—

Nitrate of iron at 55° B.	2 lbs.
Chloride of iron at 45° B.	1 lb.

Stir till completely cold, and finally add—

Oxalic acid	2 oz.
Chromate of potash	4 oz.

The longer this colour is kept the finer becomes the black tint.

Dark Brown.

Starch	24 lbs.
Roasted starch	24 lbs.
Extract of indigo	10 lbs.
Crystallized chloride of ammonium	2 lbs.
Extract of orchil	208 litres.
Water	20 litres.

Boil up and then add—

Alum	16 lbs.

Green.

Extract of indigo	15 oz.
Alum	5 lbs.
Oxalate of potash	25 oz.
Yellow paste	18 lbs.
Gum water	*Quant. suff.*

The "yellow paste" is prepared by adding to decoction of fustic chloride of tin and a little sulphuric acid, and filtering; the paste left on the filter should be well drained, and used while moist.

Blond.

Extract of indigo	1½ oz.
Alum	½ lb.
Oxalic acid	½ lb.
Extract of fustic, Extract of orchil, Gum water	As required.

Reimann's Färberzeitung, No. 38, 1874.

Liquid for Cleansing and Revivifying Old Clothes.—BLANCHET patents the following mixture:—

Distilled water	1 litre.
Panama wood	200 grammes.
Alum	2 „
Acetic acid	2 „

Bull. Soc. Chim. Paris, xxii. 524.

Vandyke Red.—G. WELBORN finds that the essential constituent of this pigment is diplumbic chromate (basic chromate of lead). *Pharm. J. Trans.* [3] *iv.* 953.

Deterioration in the Colour of Cinnabar through Contact with Copper and Brass.—K. HERMANN calls attention to this fact, which has special interest to calico-printers. Though a mixture of water and cinnabar is not affected by a piece of metallic copper or brass being put into it, a certain change in colour is produced, if the metal is rubbed with a glass rod, thus showing that *intimate* contact of the cinnabar with copper or brass brings about an inter-action between the latter and the sulphur of the cinnabar.

It would appear from this observation that cylinders of the above-named metals should be avoided when printing with cinnabar. *Ber. D. Ch. G. vii.* 1486.

§ 4. *Food and Sanitary Matters.*

Analyses of Meat, as sold in the Paris Markets in 1873 and 1874.—C. MENE gives a series of elaborate analyses of various descriptions of meat, including beef (neck or collar, side or loin, leg, fillet, kidney, tongue, shoulder, top of back, between the ribs, shoulder bone, cheek, shin, sirloin, rump, breast, steak, false fillet, false shin, tail, heart, brains, lights, liver, and marrow), veal (breast, neck, kidney piece, kidney, cutlet, fillet, shoulder, head); mutton (leg, shoulder, chop, neck); pork (kidney, fillet, chop, ham, knuckle of ham, ribs); salted ham, smoked ham, lard, sausage-meat, tongue, &c. *Journal of the Chem. Soc. xii.* 1110, *from Comptes rendus, lxxix.* 396 *and* 529.

Sugar.—POTTIN removes potash from molasses by treating with tartaric acid, whereby bitartrate of potash is thrown down; the filtered liquid is then treated with lime until alkaline, and the excess of lime is removed by carbonic acid. The syrup is then decanted, warmed up, filtered, and evaporated to crystallizing. From the tartrates of potash and lime thus produced the tartaric acid is readily regenerated. *Bulletin Soc. Chim. Paris, xxii.* 523.

Purification of Sugar Products.—MARGUERITTE takes the juice after defecation, purification with animal charcoal, and evaporation to 28° to 35° B. and treats with it the sugar of the second and third crystallizations, whereby the impurities are dissolved out, but the sugar undissolved (juice at 35° being saturated with sugar); the crystals are then ground and drained in a turbine with a current of steam, and are thus purified. The presence of the molasses, thus washed out into the crude evaporated juice, has little or no effect on the character of the first crop of crystals obtained from it by further evaporation; this clarifying liquor is far less costly, therefore, than any syrup would be made from crystals by re-dissolving, especially as its quantity is large compared with the sugar to be purified, and therefore its action is more certain.

But little ash is introduced into the refined sugar thus obtained from the second and third crops. The yields may be thus tabulated:—

	Sugar.	Ash contained in the sugar.	Ash per 100 of total sugar, molasses, &c.
1st crop.	46·5		
2nd „	18·1	1·5 per cent.	= 0·27
3rd „	6·2	3·1 „	= 0·18
Molasses and loss	29·2		
	100·0		0·45

Bulletin Soc. Chim. Paris, xxii. 428.

Artificial Coffee.—LODICA, BUTIGNY, and SAULZOIR patent the use of the following composition, intended as a substitute for coffee:—

Roasted and powdered starchy matter	420 parts.
Coffee separately dried and powdered	75 „
Dry powdered hops	2 „
Groseillier black (pulverized)	2 „
Mint in powder	0·5 „
Gall nuts „	0·07 „

The composition is treated like ordinary coffee. *Bulletin de la Soc. Chim. Paris, xxii.* 477.

Tea.—G. W. WIGNER gives the following analyses and determinations of the soluble portions, &c., of tea:—

A. Average of twenty-four samples taken from chests of gunpowder, congou, pekoe, bohea, black tea, &c., as imported.

B. Average of twelve samples of teas of good quality, but obtained from retail dealers, and more or less "faced."
C. Average of four samples of genuine highly-priced teas as imported, used only for mixing with other teas (orange pekoe, Indian pekoe, Indian twankey, and summer shoots).
D. Average of twenty-one samples of retailers' tea, all more or less adulterated.

	A	B	C	D
Total ash . . .	5·66	5·77	5·57	8·78
Ash soluble in water .	3·07	2·99	2·92	2·12
Ditto, ditto, in hydrochloric acid . .	2·24	2·22	2·10	3·00
Silica	0·44	0·56	0·55	3·66
Alkali in ash (calculated as potash) . . .	1·62	1·67	1·59	—

In the case of the specimens A, there are very small deviations from the average value in each of the twenty-four instances. Greater fluctuations are noticed in the twelve samples B, owing to different amounts of facing; whilst with the twenty-one samples D, great fluctuations are found. Many of these consisted of stalks or of spent tea leaves, redried and faced. Many contained leaves other than tea, and some a considerable amount of fine stones, sand, &c., to give weight. *Journal of the Chem. Soc. xii.* 1106, *from Pharm. Journ. Trans.* [3] *iv.* 909.

Alcohol.—ROUSSEAUX patents the use of bleaching powder to purify the last distillates in alcohol rectification. The bleaching powder is dissolved in 5 or 6 times its weight of water and filtered; 40 to 50 centilitres of this solution are added to every 600 to 650 litres of alcohol, the whole well agitated in a cask, and then left to stand for four to six days; after decantation, an alcohol is obtained without any bad taste. With very low qualities of distillates bleaching powder solution, up to 2 or 3 litres, may be used, whereby a great improvement in taste and odour is occasioned; the results of this method are said to be superior to those obtained by the use of wood charcoal. *Bulletin Soc. Chim. Paris, xxii.* 526.

New Antiseptic.—A. H. LENDEMANN patents the use of boric acid and its compounds, which are all-powerful in protecting every kind of organic matter against decay, as well in the living as in the dead state. They are used in (1) preserving fresh meat, blood, and its compounds, like albumen and fibrin; (2) embalming corpses; (3) protecting textile tissues against mildew; (4) curing and preventing contagious and miasmatic diseases.

Food Supply in China.—Mr. Colton Salter, late United States Consul at Hangkow, a city seven hundred miles up the Yang-tse-Kiang, has sent to the "New York Times" some particulars respecting pisciculture in China, and other artificial methods there practised for the multiplication of alimentary substances of every kind. On the Yang-tse-Kiang, a mighty river three thousand miles long, are thousands of establishments devoted to the artificial culture of fish. According to existing treaties, the stream is only open to commerce up to Ching-Tsing, Kiang-Kiang, and Houkow; but Mr. Colton Salter has explored it as far as Yochow and lake Yang-Tsing, the great lake of the empire.

The Chinese are peculiarly an ichthyophagous people, and when we bear in mind that, in the opinion of some geographers, the country contains 500,000,000 of people, we may conceive the enormous consumption of fish, and the absolute necessity of artificial means of keeping up the supply. The shad (sam-li), a very excellent fish, is obtained almost exclusively by artificial propagation, and is sent all over the country packed in *cangs*, or large jars of coarse china.

The extreme density of the population has in some sort given an over-development to human industry, hence the extended, and withal successful efforts that have been made to render the supply of food equal to the demand.

To take the single instance of artificial incubation. The traveller sees how little progress has been made in the art in Europe and America. In China, on the contrary, he finds in every village flocks of fowls, ducks, and geese, with perhaps five hundred in each flock. A boy tends them with a bamboo cane. All are the produce of artificial incubation. The result is that fowls are very cheap in China; ten good pullets may be bought for a thousand cash, or about five francs. Eggs are also very cheap, for the Chinese possess the secret of increasing the fecundity of their birds. Even in the towns five fresh eggs may be bought anywhere for five centimes. It must be admitted that other countries are still profoundly ignorant of the resources of this marvellous land. *Les Mondes, 17th Dec.* 1874.

Action of Hot Water on Lead.—I. PIERRE finds that when the vapour of water is passed through a leaden worm so rapidly that it is only partially condensed, the effluent water is opalescent, and on standing deposits hydrated carbonate of lead. The amount of substance thus deposited amounted in some experiments to 0·0747 grammes per litre, whilst 0·00375 grammes remained dissolved in the clear filtered liquid. *Comptes rendus, lxxviii.* 1265.

H. E. ROSCOE finds the following as the composition of a white mass taken from the inside of the covering of a leaden hot water cistern fed with Manchester Corporation water:—

Lead oxide	85·67
Carbonic acid . . .	12·12
Water	2·21
	100·00

Stalactitic masses hung down from this cover from ¼ to ½ inch in length, and the whole surface was much honeycombed. Hence it is evident that hot water rapidly corrodes lead even when the water is of such a nature as to have no appreciable action on the metal when cold; probably the action is due to the condensed steam absorbing oxygen from the air, and then forming hydrocarbonate of lead (hydrated carbonate of lead). *Paper read before the Manchester Lit. and Phil. Soc. Nov. 3rd,* 1874.

Bones.—J. W. MALLET finds that the dry and partially bleached bones of the bison (so-called buffalo) from the American plains and prairies (which are collected and sent into the market in some quantity for manure), contain almost as much nitrogenous matter as fresh bone, notwithstanding the brittleness of the substance, indicating that the bones had in many cases been exposed to the action of the weather for long periods of time; thus he gives the following analysis of an average sample of this material:—

Fatty matter	0·72
Osseine	28·69
Phosphate of lime	49·44
Phosphate of magnesia . . .	2·31
Fluoride of calcium	0·44
Carbonate of lime	7·54
Lime	0·71
Chloride of sodium	0·11
Silica	1·26
Water lost at 105°	8·27
Potassium, manganese, and sulphate of soda	traces.
Sesquioxide of iron	0·10
Substances undetermined and loss .	0·41
	100·00

Chemical News, xxx. 211.

Remedy against Phylloxera.—Amongst the innumerable substances recommended for the destruction of this scourge of the vine, sulpho-carbonate of barium has of late been mentioned. This is prepared on the large scale by agitating a concentrated warm solution of barium sulphide with carbon bisulphide, when the barium sulpho-carbonate separates in crystals. *Ber. D. Ch. G. vii.* 1545.

Improved Filter.—LESTONNAT constructs filtering apparatus of a cylinder, containing two perforated diaphragms, containing the filtering material between them; when this material gets more or less blocked by the deposition of solid matters, the filter is reversed, and the impurities washed away by a current of water. The perforated diaphragm may be conveniently made of metal gauze, with a solid perforated plate under the lower one to support it. *Bulletin Soc. Chim. Paris, xxii.* 432.

Disinfection of Cattle-Sheds.—In the "Journal des Chemins de fer et de la Navigation à Vapeur de l'Autriche," we find the subjoined account of experiments made at the village of Swejkow, in Hungary:—

On an estate of some 60 ares in extent stands a distillery where the grains are used for stock feeding. The cattle-shed is built with walls, and covers an area of about 1,200 square metres. An adjoining building serves as a store for the pulp; the dung-heap occupies about 1,500 square metres, and at the time spoken of contained 1,000 cubic metres of dung. The floor of the shed was laid with dung 20 centimetres in depth. In the shed were 172 head of cattle. The cattle-plague showed itself on March 6, 1874. On 13th March, 23 of the animals had fallen victims; the rest were accordingly ordered to be slaughtered. It was ascertained that out of the 149 beasts slaughtered, 48 had been already attacked by the disease. The shed was then carefully closed, and so remained until 28th

April, the date of the arrival of the committee appointed to make experiments in disinfecting it.

The latter were performed with Fraenkel's "Defæcator."

The work was executed by eight men in the following manner :—

In a copper holding about 4 hectolitres, 3 kilogs. of the material in question, a red powder giving off a strong odour of carbol, was dissolved in water, and well stirred; at the end of half-an-hour the solution had assumed a brick-red tint. M. Fraenkel then poured into it about 150 grammes of concentrated carbolic acid. The liquor thus prepared was spread over the floor of the shed, and, with the aid of brushes, the walls, doors, windows, rafters, &c., were all well soused with it. The drains connecting the shed with the dung-heap were washed down with 2½ hectolitres of the solution strengthened with 60 grammes of carbolic acid. In all, about 20 hectolitres of the liquor were used, containing 15 kilogs. of defæcator and 0·750 of concentrated carbolic acid.

The execution of the work took from the morning of 29th until noon of the 30th. The shed was then closed for thirty-six hours. To disinfect the dung-heap the surface was taken off to a depth of 30 centimetres, and holes were made in it with pointed stakes. Every portion of the uncovered surface was sprinkled with the disinfectant, and the holes were filled with the same. This occupied 36 hours, and consumed 65 hectolitres of mixture, containing 50 kilogs. of defæcator.

On 2nd May, the shed was re-opened to again disinfect the dung on the floor, for which purpose 30 hectolitres of liquor, containing 30 kilogs. of defæcator, were used.

The following days, up to the 6th May, were occupied in disinfecting the yard and the ground adjacent to the building. For this purpose 17 hectolitres of liquor were employed, containing 30 kilogs. of defæcator.

Altogether, the operations consumed 185 hectolitres of water, 140 kilograms of defæcator, and 0·750 of carbolic acid. The disinfecting material, exclusive of carriage from Vienna, cost 35 francs per 100 kilogs., and the carbolic acid 2 francs per kilog.

On the 6th May, two perfectly healthy cows were placed in the shed, and kept there for 21 days. On the 27th May they were killed and dissected by a veterinary surgeon deputed for the purpose. Autopsy proved that the internal organs of both animals were perfectly healthy, and that in neither was there the slightest trace of the disease.

The results of the experiments were sufficiently satisfactory to encourage the experimenter to repeat them on a larger scale on a future opportunity. *Revue Industrielle, 16th Dec.* 1874.

§ 5. *Fuel, Heating, Gas, Illumination, Photography, &c.*

Classification of Coals.—L. GRÜNER divides coals for industrial purposes into five classes, the distinction between which are well marked, although different specimens may exhibit characters intermediate between two classes; by heating the coals in a retort and incinerating the residue, the *agglomerative power* as well as the *calorific power* may be determined. The author gives the following table :

Class.	Composition.	Ratio of Carbon to Hydrogen.	Percentage of Coke left on Distillation.	Character of Coke.
1. Dry coal: flame long	Carbon 75 to 80 Hydrogen 5·5 to 4·5 Oxygen 15 to 19·5	4 to 3	50 to 60	Pulverulent or at most only fritted.
2. Fat coal: flame long (gas coal)	Carbon 80 to 85 Hydrogen 5·8 to 5 Oxygen 10 to 14·2	3 to 2	60 to 68	Fused, but porous.
3. Fat coal proper, or forge coal .	Carbon 84 to 89 Hydrogen 5 to 5·5 Oxygen 5·5 to 11	2 to 1	68 to 74	Fused, moderately compact.
4. Fat coal: flame short (coking coals) . . .	Carbon 88 to 91 Hydrogen 5·5 to 4·5 Oxygen 5·5 to 6·5	1	74 to 82	Fused, but little porous.
5. Poor coal (anthracites) . .	Carbon 90 to 93 Hydrogen 4·5 to 4 Oxygen 3 to 5·5	1	82 to 90	Fritted or pulverulent.

Bulletin Soc. Chim. Paris, xxii. 417*; from Annales des Mines*, [6], *iv.* 169.

Red Charcoal.—This name is given to wood that has been only partially carbonized in closed vessels, the operation being discontinued as soon as water and acetic acid cease to pass over; this charcoal possesses a much greater calorific power than completely burnt black charcoal. Reichenbach finds their calorific effects to be in the ratio of 27 to 16; moreover, red charcoal is less brittle and more readily carried. *Chem. Centralblatt*, 1874, 171. and 188.

Purification of Coke.—S. DE NOMAISON patents a process in which the coal, &c., is heated to redness with exclusion of air, whereby the pyrites or bi-sulphide of iron which it contains is converted into protosulphide. It is then received in tanks containing water to which is added hydrochloric acid, which dissolves the protosulphide of iron, disengaging sulphuretted hydrogen, and also dissolves other of the earthy matters present. The coke is then washed with water and dried. The process is most readily effected upon small coke or dust, and it is therefore in some cases preferable to pulverize the material in the first place and to agglomerate it into blocks after purification. The process is applicable to peat and anthracite; and lignite treated in this manner gives a product which has the qualities of wood charcoal.

Ponsard Gas Furnace.—PÉRISSÉ states that this furnace consists essentially :—(1) Of a gazogène in which the fuel in a solid state undergoes incomplete combustion or is transformed into gases which are themselves combustible; (2) of a hot air apparatus, heated by the lost flames, called by its inventor a *heat recuperator*, and placed below the furnace proper; (3) of what is called a furnace-laboratory, in which the gases from the gazogène are submitted to complete combustion by means of the hot air from the recuperator. There are two forms of gazogènes, one fed with hot and the other with cold air. The principal applications which have been made at present of this system of heating are : the heating and welding of iron, the fusion of steel and cast iron, the reheating of steel, puddling of iron, and treatment direct of ores of iron and of zinc; glass bottle, gas, and chemical manufactures; and the heating of steam boilers.

For the former purpose, this system possesses great advantages; thus in five instances results of the following character were obtained : a saving of something like 50 per cent. in the fuel used is occasioned; a fuel of considerably less value than ordinary coal can be used, such as lignite, turf, fuel, cinders, &c.; less waste is experienced; and a larger amount of material can be worked or heated in such furnaces than in the ordinary ones.

Comparing the quantities of heat lost and utilized in the gas-furnaces of Siemens and Ponsard, the author claims for the latter a superiority over the former amounting to 5 or 6 per cent. in the economy of fuel when the ordinary gazogène is used, and from 10 to 13 per cent. when the gas is produced by means of the hot blast from the recuperator. And in addition to this the Ponsard furnace costs less than half as much as the Siemens. Another economy in these gas-furnaces is the saving of about 40*s.* a day in the diminution of waste iron.

The subject is summed up in the following terms :—With the Siemens or Ponsard gas furnaces higher temperatures are obtained with regularity than with other furnaces. The causes of their superiority consist in the fact that the fuel and the metal are in the same physical condition, their initial temperature, the possibility of mixing them in the proper theoretical proportions without admitting any notable excess of air, the possibility also of making such combination at the very point where it is required, and at a light pressure which preserves the laboratory of the furnace and the matters contained in it from the chills and alterations caused by the entrance of the outer air. The rapidity of heating depends evidently on the excess of the temperature of the flames as compared with the temperature to which the substances must be raised, so that in these gas furnaces we have at once a larger production with an important economy in fuel, independently of that which results from recuperation. *Paper read before the Society of Civil Engineers of Paris.*

Photography by Artificial Light.—DELACHANEL and MERMET have introduced a lamp which gives a light very rich in chemical rays. The media employed are carbon-sulphide and binoxide of nitrogen. Ignition of binoxide of nitrogen, containing vapour of carbon-sulphide, produces a brilliant flame of a violet-blue tint peculiarly rich in chemical rays. The carbon-sulphide lamp by which this flame is produced continuously is constructed simply of a flask with two tubulures, the vessel having about 500 cubic centimetres capacity. The flask is filled with spongy fragments of coke, or, better, of dried pumice which imbibes the carbon-sulphide. Through the central tubulure passes a tube to within a short distance of the bottom; in the other mouth or tubulure is fixed a tube of larger diameter about 20 centimetres in length. The latter tube is of glass or metal, and contains an arrangement acting as a safety-valve as well as impeding return of the gas and preventing explosion. Binoxide of nitrogen is passed by this tube into the flask, and the gaseous mixture is conducted by a caoutchouc tube to a kind of Bunsen burner, from which has been removed the air-port and the cone regulating the supply of gas. The binoxide of nitrogen is produced by a Claire-Deville apparatus,

but instead of decomposing nitric acid by copper, which would be too expensive, a mixture of nitric and sulphuric acid is caused to act upon iron.

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The admixture of chalk with coal may facilitate the access of the air to the fuel, but it will also notably increase the inconvenience arising from cinders and clinkers; the furnace will need more frequent clearing, and with some kinds of coal, which have siliceous cinders, the latter, in contact with the iron, will be apt to form siliceous concretions on the bars, thereby greatly impeding the working of the furnace.

The inference I draw from these considerations is, that such an admixture may be serviceable for domestic purposes, but it cannot be suited for steam-boilers. *M. Maridort in Les Mondes, 17th Dec.* 1874.

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In the boiler there was found, besides a paper-thick coating of the usual deposit over the whole surface that was under water, a layer (from 2 to 3 mm. thick), of pulverulent matter, on the foremost half of the boiler bottom, which was a little inclined towards the fireplace. This powder was found very difficult to wet with water. Analysis showed that the incrustation contained a soap not soluble in water; there was at least 6 per cent. fatty acid present in the form of an insoluble soap. This fatty acid must have been neutralized by a certain quantity of lime or magnesia; and, to determine this, a quantitative analysis of the deposit was made. The result was:—matter insoluble in muriatic acid (mud, sand), 16·83 per cent.; oxide of iron, 10·68; lime, 29·28; magnesia, 9·01; carbonic acid, 21·78; organic matter, 9·47; water, 2·77; total, 99·82 per cent. There was also present a small quantity of sulphuric acid, which could not be quantitatively determined. If we suppose the whole of the carbonic acid combined with lime, this will take 27·72 per cent. of lime, so that 1·56 per cent. lime and 9·01 per cent. magnesia remain available for neutralization of the fatty acid (which is included in the organic matter in the above analysis). With the proviso that the fatty acid was mainly oleic acid, the 1·56 per cent. lime would more than suffice to neutralize the acid; a portion of the alkaline earths must thus have been free, perhaps in the form of a basic carbonate, in the deposit. It appeared, at all events, from this analysis that the powder contained at least 7 to 8 per cent. of an insoluble soap. The source of the fatty matters present in this soap was distinctly traced to the waste steam blown into the feedwater. *Iron, No.* 98, *p.* 684, *from Dingler's Polytech. Journal.*

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this, but is said to amount on the average to 50 per cent. During four months' trial, this system has realized an economy of 600 to 700 francs per week in the saving of coke alone, and the lighting, which, in the olden time, consumed seven steres of wood per month, is now easily effected by means of a few shavings or pieces of waste wood. *Iron, No. c. p.* 740.

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To indemnify himself, M. Larmanjat has been authorized by government to charge the following rates :—

Distances.	Charges per ton per kilometre.	
	1st Class freight.	2nd Class freight.
Under 100 metres .	0·012 francs.	0·006 francs.
From 100 to 150 do. .	0·010 „	0·005 „
From 150 to 200 do. .	0·009 „	0·0045 „
Over 200 do. . .	0·008 „	0·004 „

Over and above these charges, a fixed royalty of 75 centimes will be levied on each keel. The charges for night work will be 50 per cent. higher.

As compared with the traction of men or horses, the system presents undoubted advantages in respect of economy and speed, and it is thought will probably meet with more extended application. *Moniteur Industriel Belge*, 1 *Dec.* 1874.

Action of Chloride of Magnesia on Boilers.—In brackish waters we meet with salts of various kinds, but there are three whose presence demands special attention : these are chloride of soda (common salt), chloride of lime, and chloride of magnesia, one never being present without the others. In all boilers fed with such water, the boiler-plates suffer, and a portion of their iron may be found in the incrustation of the sediment, to which it imparts a brick-red hue. This has always been attributed to the action of the chlorides of soda and lime ; but it is a very great mistake. These two salts undergo no decomposition or change, even at the most elevated temperatures. It is quite impossible, therefore, that they can affect the boiler-plates. But, side by side with these, we find chloride of magnesia, the action of which is altogether different. It is impossible to dry chloride of magnesia ; it at once resolves itself into hydrochloric acid and magnesia. If the hydrochloric acid comes in contact with the iron, it at once forms a soluble chloride of iron in the water. This is precisely what happens in boilers fed with brackish water. The chloride of magnesia, like the other salts, is supplied by the water. The water evaporates on the superheated surfaces about the throat of the boiler and the pipes which conduct the steam to the piston ; it leaves on these surfaces a deposit of chloride of magnesia, which decomposes and attacks the ironwork, the copper, the pipes, and the brasswork of the cocks. The change is still more apparent in the parts where there is steam room. Under such circumstances, chloride of iron forms, which dissolves in the water in contact with the carbonate of lime contained in the latter ; chloride of lime and red oxide of iron are thus formed, which are found in the deposit. Chloride of magnesia may be looked upon as a very injurious adjunct, even when present in very small quantities. A case in point lately occurred in one of the largest manufacturing establishments in the neighbourhood of Rouen, where the boilers were supplied with brackish water containing only 6 grammes of chloride of magnesia to the hectolitre. A contingency of this sort often happens at seaports. The writer has met with one instance of the kind in artesian well water, at Elbœuf. Unfortunately, there is no known practical method of getting rid of the salt in question ; but its effects should be recognized, as too often they prove a source of dispute between boiler-makers and their customers, who, when they detect injuries of the kind described, are apt to attribute them to the inferior quality of the iron employed. *Les Mondes*, 10*th Dec.* 1874, *from Annales de l'Industrie.*

Boiler Explosions.—At the Ougrée Ironworks, Liége, a discovery has lately been made of a hitherto unrecognized, but probably by no means uncommon, cause of boiler accidents. Not long since the tube of a boiler heated by the waste heat of a puddling furnace burst, happily without doing much damage. On examining the rent, it was found that for a certain length along the line of fracture, the boiler-plates were corroded, so as to leave a thickness of not more than a single millimetre. The adjacent parts were perfectly sound and untouched, the iron was of good quality, the boiler not an old one by any means, and, like all others in the same establishment, had been subject to a very strict, indeed a minute supervision ; moreover, the fracture was *not* in the direct line of the draught. Conjecture as to the cause of the mischief appeared hopeless. When, however, the repairs were made, the workmen noticed that their hands were soiled with some substance which would not wash off, and which in the course of a few hours showed very unmistakeable signs of corrosive action upon their clothes. It was a sticky substance, of blackish or dark yellowish hue, and speedily liquefied when spread out to the air. Analysis showed it to consist chiefly of ferrous sulphate, *with* 11·85 *per cent. of free sulphuric acid.* Here was the solution of the mystery. This formation of sulphuric acid and its deposition on heat-generating surfaces is evidently a very real source of risk wherever mineral fuel is employed ; for the coal used at Ougrée contains as little sulphur as any in Belgium—much less than German coal. It is recommended that all external portions of boilers and boiler tubing not completely covered in with brickwork, should be made easy of access, and be constantly cleaned. Corrosive deposits of the kind in question may generally be looked for on surfaces *not* in direct contact with the flame and draught. *Moniteur Industriel Belge*, 1 *Dec.* 1874.

Wire Gauges.—In consequence of the adoption of a millimetre wire-gauge in Austria, it has been decided that, as the millimetre gauge had met with the approval of the majority of Austrian wire-workers, a similar arrangement should be recognized in the German trade. The table annexed gives the sizes corresponding with the several numbers of the millimetre (Austrian) and Westphalian (German) gauges as compared with the Birmingham and Paris wire-gauges :—

Size of wire in millimetres.	Millimetre gauge.	Birmingham gauge.	Paris gauge.	Westphalian gauge.
10	100	—	30	——
8·8	88	0	28	——
7·6	76	1	26	"Ketten."
6·0	60	4	23	"Grob Rinkel."
4·6	46	7	—	"Malgen."
3·4	34	10	18	"Feine Memel."
1·6	16	16	11	2 Band.
1·2	12	18	7	3 „
0·9	9	20	4	6 „
0·5	5	25	P.	1 Hol or 4 Blei.
0·34	3	29	—	5 „ or 8 „
0·2	2	33	—	11 „ or 17 „

Zeitschrift des Vereines Deutscher Ingenieure, xviii.

Safety Apparatus for the Instantaneous Stoppage of Steam Machinery.—In view of the lamentable accidents which too frequently occur in manufacturing establishments, through the extent and complexity of the gearing or the foolhardiness of workpeople, M. Hallez, of Lille, has sought to prevent, so far as possible, the fatal consequences which may result from unforeseen causes of this description, by providing for the *instantaneous* stoppage of the motive agency setting the machinery at work.

The system has already been adopted in several manufacturing

but instead of decomposing nitric acid by copper, which would be too expensive, a mixture of nitric and sulphuric acid is caused to act upon iron.

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To indemnify himself, M. Larmanjat has been authorized by government to charge the following rates :—

Distances.	Charges per ton per kilometre.	
	1st Class freight.	2nd Class freight.
Under 100 metres .	0·012 francs.	0·006 francs.
From 100 to 150 do. .	0·010 „	0·005 „
From 150 to 200 do. .	0·009 „	0·0045 „
Over 200 do. . .	0·008 „	0·004 „

Over and above these charges, a fixed royalty of 75 centimes will be levied on each keel. The charges for night work will be 50 per cent. higher.

As compared with the traction of men or horses, the system presents undoubted advantages in respect of economy and speed, and it is thought will probably meet with more extended application. *Moniteur Industriel Belge*, 1 *Dec.* 1874.

Action of Chloride of Magnesia on Boilers.—In brackish waters we meet with salts of various kinds, but there are three whose presence demands special attention : these are chloride of soda (common salt), chloride of lime, and chloride of magnesia, one never being present without the others. In all boilers fed with such water, the boiler-plates suffer, and a portion of their iron may be found in the incrustation of the sediment, to which it imparts a brick-red hue. This has always been attributed to the action of the chlorides of soda and lime ; but it is a very great mistake. These two salts undergo no decomposition or change, even at the most elevated temperatures. It is quite impossible, therefore, that they can affect the boiler-plates. But, side by side with these, we find chloride of magnesia, the action of which is altogether different. It is impossible to dry chloride of magnesia ; it at once resolves itself into hydrochloric acid and magnesia. If the hydrochloric acid comes in contact with the iron, it at once forms a soluble chloride of iron in the water. This is precisely what happens in boilers fed with brackish water. The chloride of magnesia, like the other salts, is supplied by the water. The water evaporates on the superheated surfaces about the throat of the boiler and the pipes which conduct the steam to the piston ; it leaves on these surfaces a deposit of chloride of magnesia, which decomposes and attacks the ironwork, the copper, the pipes, and the brasswork of the cocks. The change is still more apparent in the parts where there is steam room. Under such circumstances, chloride of iron forms, which dissolves in the water in contact with the carbonate of lime contained in the latter ; chloride of lime and red oxide of iron are thus formed, which are found in the deposit. Chloride of magnesia may be looked upon as a very injurious adjunct, even when present in very small quantities. A case in point lately occurred in one of the largest manufacturing establishments in the neighbourhood of Rouen, where the boilers were supplied with brackish water containing only 6 grammes of chloride of magnesia to the hectolitre. A contingency of this sort often happens at seaports. The writer has met with one instance of the kind in artesian well water, at Elbœuf. Unfortunately, there is no known practical method of getting rid of the salt in question ; but its effects should be recognized, as too often they prove a source of dispute between boiler-makers and their customers, who, when they detect injuries of the kind described, are apt to attribute them to the inferior quality of the iron employed. *Les Mondes*, 10*th Dec.* 1874, *from Annales de l'Industrie.*

Boiler Explosions.—At the Ougrée Ironworks, Liége, a discovery has lately been made of a hitherto unrecognized, but probably by no means uncommon, cause of boiler accidents. Not long since the tube of a boiler heated by the waste heat of a puddling furnace burst, happily without doing much damage. On examining the rent, it was found that for a certain length along the line of fracture, the boiler-plates were corroded, so as to leave a thickness of not more than a single millimetre. The adjacent parts were perfectly sound and untouched, the iron was of good quality, the boiler not an old one by any means, and, like all others in the same establishment, had been subject to a very strict, indeed a minute supervision ; moreover, the fracture was *not* in the direct line of the draught. Conjecture as to the cause of the mischief appeared hopeless. When, however, the repairs were made, the workmen noticed that their hands were soiled with some substance which would not wash off, and which in the course of a few hours showed very unmistakeable signs of corrosive action upon their clothes. It was a sticky substance, of blackish or dark yellowish hue, and speedily liquefied when spread out to the air. Analysis showed it to consist chiefly of ferrous sulphate, *with* 11·85 *per cent. of free sulphuric acid.* Here was the solution of the mystery. This formation of sulphuric acid and its deposition on heat-generating surfaces is evidently a very real source of risk wherever mineral fuel is employed ; for the coal used at Ougrée contains as little sulphur as any in Belgium—much less than German coal. It is recommended that all external portions of boilers and boiler tubing not completely covered in with brickwork, should be made easy of access, and be constantly cleaned. Corrosive deposits of the kind in question may generally be looked for on surfaces *not* in direct contact with the flame and draught. *Moniteur Industriel Belge*, 1 *Dec.* 1874.

Wire Gauges.—In consequence of the adoption of a millimetre wire-gauge in Austria, it has been decided that, as the millimetre gauge had met with the approval of the majority of Austrian wire-workers, a similar arrangement should be recognized in the German trade. The table annexed gives the sizes corresponding with the several numbers of the millimetre (Austrian) and Westphalian (German) gauges as compared with the Birmingham and Paris wire-gauges :—

Size of wire in millimetres.	Millimetre gauge.	Birmingham gauge.	Paris gauge.	Westphalian gauge.
10	100	—	30	——
8·8	88	0	28	——
7·6	76	1	26	"Ketten."
6·0	60	4	23	"Grob Rinkel."
4·6	46	7	—	"Malgen."
3·4	34	10	18	"Feine Memel."
1·6	16	16	11	2 Band.
1·2	12	18	7	3 „
0·9	9	20	4	6 „
0·5	5	25	P.	1 Hol or 4 Blei.
0·34	3	29	—	5 „ or 8 „
0·2	2	33	—	11 „ or 17 „

Zeitschrift des Vereines Deutscher Ingenieure, xviii.

Safety Apparatus for the Instantaneous Stoppage of Steam Machinery.—In view of the lamentable accidents which too frequently occur in manufacturing establishments, through the extent and complexity of the gearing or the foolhardiness of workpeople, M. Hallez, of Lille, has sought to prevent, so far as possible, the fatal consequences which may result from unforeseen causes of this description, by providing for the *instantaneous* stoppage of the motive agency setting the machinery at work.

The system has already been adopted in several manufacturing

establishments, amongst others, in the great spinning-mills of M. Godefroy Parenthon, at Roubaix.

Experiments instituted officially have proved that the stoppage is really instantaneous, in the literal sense of the word, even when the particular machine, which is the immediate cause of the disaster, is situate at some distance from the motor.

For instance: on the fifth floor of a factory, the stoppage is effected by pressing a button placed close to each machine, a touch on which suffices to shut off the steam without giving notice to the engine-driver, and independently of his co-operation or assistance. When a break-down occurs, either in the engine itself or in some part of the machinery, the instantaneous stoppage will prevent disastrous consequences, which, in a pecuniary point of view, are not infrequently serious. The safety apparatus is, therefore, a valuable adjunct in all establishments using steam-power. Its adoption is a question of economy as well as of humanity.

On the steam-pipe the inventor places a stop-cock, which is kept open whilst the machinery is at work, but which, as soon as it is turned, precludes any steam coming from the boiler from entering the cylinder; the turning of this cock causes the instant stoppage of the machinery. With it the engine-driver shuts off steam in the ordinary way; but when an accident happens, a longer or shorter interval must elapse before notice can be given to the engine-driver, and we all know, that in cases of this description, a second's delay may involve serious disaster; yet this is what usually does happen in establishments unprovided with the apparatus in question.

Now let us see what M. Hallez has attempted. He has sought to supplant the engine-driver in such cases by providing, at every point of the work-rooms, a means of shutting off the steam automatically, and thus stopping the machinery.

To solve this triple problem, M. Hallez places close to the steam-cock a cast-iron shaft carrying at its upper extremity a cylinder of large dimensions, containing a powerful wrought-steel spring. This spring is connected with a lever placed above it, to which is attached a metal wire, with branches leading into every room, and terminating in a button, within easy reach of every one in the room, by pressing upon which the apparatus is worked and the machinery stopped.

When one of these buttons is pressed, it imparts a movement to the lever spoken of above, which releases the steel spring. The spring in its rebound carries with it a bolt, which strikes with great force on the steam-cock, closing the lathes, and thus shutting off the steam and stopping the machinery at the same instant.

From this brief description it will be seen that nothing can be more simple or easier to arrange than M. Hallez's safety-apparatus. As we have before said, its adoption is a matter of grave moment in regard of humanity, an improvement which should be neglected by no one, as the apparatus is entitled to a prominent place amongst useful inventions. *Moniteur Industriel Belge*, 20*th Dec.* 1874.

Price of Locomotive Engines in Germany.—A Berlin journal states that the contract price of locomotive engines in Germany has been steadily declining during the last two years past. During the last twenty years the prices have averaged 1·50 francs per kilog., tender included. The highest price, two francs per kilog., was paid during the first half of 1872, and previously, in 1858. *Revue Industrielle*, 2*nd Dec.* 1874.

Employment of Dynamite in breaking up old Ordnance.—A series of experiments have been recently made at Brest, with a view to determine the suitability of dynamite for breaking up old guns. It appears that along the French coast are considerable numbers of old cast-iron guns, of obsolete patterns, which have been hitherto unsaleable for re-casting on account of their weight and the consequent cost of carriage.

It was understood, however, that the trade would buy them up if the metal were handed over in more manageable sizes. Instructions were therefore sent to the artillery at Rennes and Brest to ascertain how far the breaking-up process could be carried out with due regard to economy.

The total weight of the eight guns and mortars experimented upon amounted to 34,058 kilogs. To break them up 35·472 kilogs. per ton of dynamite were used. The weight of broken metal collected was 33,998 kilogs. The loss was 60 kilogs., or 2·496 kilogs. per ton. Further experiments are needed to allow the exact proportions of dynamite requisite in each class of gun to be formulated; but it is considered to have been proved that where the personnel and matériel required for the operation are close at hand, the application of dynamite offers a cheap and efficacious method of attaining the object in question. *Revue d'Artillerie, November*, 1874.

Cellulose Dynamite.[1] — An officer of the Austrian engineers, M. TRAUZL, has succeeded in manufacturing with nitro-glycerine a powder, which has all the advantages of dynamite made with kiesel-guhr or infusorial sand, whilst, like gun-cotton, it is unimpaired by the action of water. M. Trauzl had long remarked that certain absorbent substances of organic origin possessed the property of keeping the nitro-glycerine absorbed by them intact in water, the nitro-glycerine itself retaining its full explosive powers. The absorbent substance used, nitrified cellulose, like gun-cotton, is not to be generally employed in large quantities on account of the danger involved in its use. M. Trauzl has, however, found in cellulose prepared in a particular way, an absorbent perfectly suited to his purpose, which will take up 70 to 75 per cent. of nitro-glycerine, forming therewith an explosive substance, which possesses the property of taking up a fixed proportion of water only, and after pressing and drying, recovering its original power.

When by abundant admixture with water, it has lost its inflammability, and is almost insensible to the most violent mechanical shocks, it still retains its hold on the nitro-glycerine, and without drying, may be fired with a match or amadou capsule, so as to produce a powerful explosion. *Moniteur Industriel Belge*, 20*th Dec.* 1874.

§ 7. *Building, Decoration, &c.*

Plaster of Paris.—E. LANDRIN finds that by heating gypsum to a much higher temperature than that usually employed (about 150° when the plaster produced retains seven to eight per cent. of water) it is possible to obtain a product which sets rapidly to a hard mass; but to obtain this result the heating must not be prolonged too far: about forty minutes at 400° gives a good result. If the heating be too prolonged, the plaster will still set, but is soft, and can readily be scratched by the nail. Up to a dull red heat a good plaster can be made, but at a cherry red the plaster frits, and will not afterwards unite with water.

The process of "aluming" plaster does not introduce any elements into the plaster not naturally there, wherefore the author regards it as chiefly acting by converting carbonate of lime into sulphate; thus the following analyses of "alumed" plasters are given:—

	French Cements.	English Cements.		Stucco.
Sulphate of lime .	96·75	98·19	98·02	98·05
Carbonate of lime .	1·05	0·41	0·37	0·36
Silica . . .	0·72	—	0·42	0·51
Water . . .	1·48	1·40	1·19	1·08
	100·00	100·00	100·00	100·00

These plasters did not set for ten to twelve hours, but they then acquired a very great hardness.

The action of alumining being only to destroy the majority of the carbonate of lime present, other sulphates, and especially sulphuric acid, ought to produce the same result, and this the author finds to be the case; care, however, must be taken not to add an excess of acid: the baked plaster is mixed with a little water and sulphuric acid for some minutes, then drained, and again baked at a dull red heat for two or three hours; if sufficient acid has been added to convert all the carbonate into sulphate, the product sets in ten or twelve hours to a very hard mass. The best result is obtained by plunging the crude plaster into a solution containing eight to ten per cent. of sulphuric acid. *Comptes rendus, lxxix.* 231.

The same author finds that the setting of plaster depends on the following circumstances:—Firstly, the particles of plaster assume a crystalline appearance on treatment with water; secondly, the water dissolves some of the crystals; and thirdly, a portion of the liquid evaporates, whereby a fresh crystal is deposited, which determined the crystallization of the whole mass. The maximum hardness is only attained after some time; at this point the relation between sulphate of lime and water is that indicated by the formula $SO_4 Ca + 2 H_2 O$. Usually too large a proportion of water is added to plaster, wherefore it remains soft and porous, and dries slowly; if this result is specially desired, the too rapid setting caused by the addition of too little water may be conveniently obviated by adding a small quantity of gum, glycerine, gelatine, &c.: inert matters, like sulphate of barium or sand, however, will not delay the setting, they only make the resulting mass less coherent and solid. The above-

[1] The reader is aware that the name *dualine* has been given to an explosive preparation composed of nitrified sawdust impregnated with nitro-glycerine.

described method of treating plaster with sulphuric acid is, however, the best means of leading to the desired end.

When it is desired to accelerate the setting of plaster, various hygrometric substances may with advantage be applied to its surface, such as common salt, anhydrous carbonate of soda, or sulphate of copper, &c.; in the case of over-baked plasters, the setting may be accelerated by the admixture of a little ordinary plaster, which in setting itself induces the setting of the rest.

During calcination of plaster at a red heat, a part of the carbonate of lime present is converted into quick-lime; whilst hydrating this evolves heat, and determines a more rapid solidification; it also communicates greater hardness, probably by taking up carbonic acid from the air. Plasters containing ten per cent. of lime give good results; the author has succeeded in making good cements containing as much as seventy-five per cent. of lime. *Comptes rendus, lxxix.* 658.

Artificial Marble.—A mixture of plaster of Paris, cement, and white of egg, when boiled together in water, produce a substance capable of high polish and resembling white marble. Of course, the addition of some pigment will permit the manufacture of coloured varieties of marble. Instead of boiling, an aqueous solution of gallic acid may be used for coagulating the albumen.

Preservation of Wood.—MAXIME PAULET compares the relative advantages of copper sulphate and creosote for this purpose. As regards the former preservative, this salt is poisonous to the vegetable and animal parasites which appear at the beginning of all organic decomposition. The quantity of salts of copper should be excessive when the wood is intended to be immersed in water or buried in a moist soil, because the water dissolves this salt slowly; and since sea water enters into combination with it still more rapidly, it should be excluded from use for wood used in the sea. There is, in wood impregnated with the salts of copper, a portion of the sulphate closely united with the ligneous tissue and another portion in excess remaining free. The latter portion dissolves first, and, carried off by the exterior fluids, only retards the loss of the metallic salt combined with the wood; but this combination itself, although more stable, does not escape removal, being accelerated or retarded according to the rapidity and ease with which the dissolving liquid is renewed. On the contrary, the quantity of metallic salts should be diminished in wood intended for constructions in the open air, in order to prevent the mechanical effect of intra-vascular crystallizations.

As regards creosote oil, it is beyond doubt that the petroleum products, containing phenic acid, are preferable to the metallic salts for wood exposed to sea-water, because naphthalene, and especially phenic acid, exert an antiseptic action, coagulate the albumen, and thus obstruct the circulation of the sap or blood of parasites. The volatility and the solubility of these preservative agents would render their antiseptic action temporary only, if the more fixed and thicker oils which accompany them did not inclose and retain the preceding substances, at the same time obstructing all the pores of the wood, and rendering difficult the access of dissolving liquids and destructive gases. On the other hand, grave objections have been raised, from a practical point of view, either because of the restricted production of these oils, which is not sufficient for a general use of them, or because the wood thus impregnated offers great danger from fire, this wood once on fire being unextinguishable; on the other hand, sulphate of copper, like all the metallic salts, renders wood uninflammable. *Treatise on the Preservation of Wood, Foods, and various Organized Matters.*

Transferring the Grain of Wood.—Graining has always been one of the most difficult branches of the house painter's trade. We do not mean that kind of graining which is too often seen, and which does not at all imitate the wood it is intended to represent, but good graining, which looks like the natural wood itself, and if well executed, is one of the most tasteful ornamental styles of house-painting. There is, besides proper training, also a certain natural disposition required in order to make a good grainer. Many house-painters can never succeed in this line, and therefore the invention of Mr. J. R. Cross, enabling anyone to transfer the grain of various kinds of wood to be imitated to a painted surface, is of great value, more so as the operation is very simple and expeditious, requiring very little time. The operation requires only two kinds of tools; first, a board of the wood of which the grain is to be transferred, and next an elastic roller to take up the paint and transfer it to the surface to be grained. It is well to select a board of which the grain is such that the pores admit of a liquid paint, which is first spread over the surface, and the surplus removed by a flat-edged scraper. Then an elastic roller, similar to those used by printers for ordinary printing presses, is run over the surface of the board, and as this takes the paint up which is left in the pores of the wood, it will receive on its surface a *fac simile* impression of the grain, which is then easily transferred to any given surface over which the roller is passed. Five rollers of differently graduated widths, inclosed in a box, is the way in which they are delivered by Messrs. Cross and Bastine, of New York, to those who wish to take advantage of their invention. We had the pleasure, at the fair of the American Institute for 1873, of inspecting this invention as one of the judges, and of recommending the silver medal which was awarded; but it is a greater pleasure to us to see now that Messrs. Cross and Bastine have improved on their invention, and are now able to imitate the grain of such wood as possesses too few or too minute pores to take up sufficient paint for the roller; for instance, some kinds of rosewood or French walnut, which, notwithstanning they show the finest grained figuring, are very close in regard to porosity. This difficulty is overcome by simply scratching and deepening the dark parts, lines, or points with a steel tool, so as to make room for the deposit of paint, and as such boards, if of very fine grain, are valuable, electrotype copies are taken, and delivered with the rollers. Messrs. Cross and Bastine have also established a system of exchange by which painters may be provided successively with a variety of electrotype models to transfer from. It must not be supposed that one of these models gives only one figure of grain, as by twisting the roller or by using it in oblique or transverse directions, the grain may be so changed as to become entirely different and unrecognizable, notwithstanding it always shows the special character of the wood. It matters not whether the surface to be grained be flat and even, or panelled and moulded, the work can be performed by this process ten times faster than by the common hand grainer's method, and at less cost. Impressions from assumed designs, etched on glass, slate, wood, or metal, may in the same way be taken and applied with indelible fidelity to any kind of fabric, even to wire cloth. The most complex and delicate lace work, too, may be pictorially reproduced by this process. In fact, any configuration can be faithfully copied by it. But so far its most important service next to its original purpose of wood graining, is in wall-paper graining. In this line of manufacture it ought to be invaluable, as heretofore the imitations of natural woods made upon paper have been made from engraved blocks, the designs being drawn by hand, and though frequently very admirable representations, were necessarily not faithful copies of any specific piece of nature. A new machine just patented by Mr. Cross for this particular class of work, and which he has already sold the working right of to a paper-hanging manufacturing concern in New York, will turn off 4,000 rolls of grained paper daily. A room therefore papered with the paper printed by this machine must necessarily have the appearance of being walled by the substantial wood from which it is printed. The method has become quite popular, and has been used in several churches and hotels, by furniture manufacturers, and by undertakers on coffins; 412 licenses and sets of tools have already been sold.—*American Artizan.*

§ 8. *Miscellaneous.*

Bone Glass.—FISCHER states that a peculiar kind of frosted glass is prepared by the addition of bone earth to ordinary glass, the frosting being due to incomplete decomposition of the phosphate of lime. Of late cryolite has been used in place of bone earth. In this case, possibly, the frosting is caused by the evolution of hydrofluoric acid. *Chem. Centralblatt*, 1874, 186.

Earthenware Glaze.—Silicate of potash of soda at 35° B. may be used either alone or mixed with 20 per cent. of red lead and 5 per cent. of silica. The thick varnish is brushed over the half burnt articles, which are then dried and burnt. The same glaze can be used for statuettes, &c., being quite indestructible when properly burnt in. *Dingler's Polytech. Journal, ccxi.* 488.

Colour Printing on Porcelain Stone Ware, &c.—The following composition is recommended for the printing oil, either under or on the surface of the glaze:—

Red lead	100 grammes.
Linseed oil	18 ounces.
Rape oil	12 „
Stockholm tar	80 grammes.
Colophony	150 „

If for use upon the glaze, the mixture is boiled as slowly as possible for two hours; if it is to be used under the glaze, a longer boiling of three and a half to four hours is requisite.

When sufficiently boiled, a drop when let fall on a plate of glass and cooled, will allow itself to be drawn into a fine thread-like filament on touching with the finger.

After printing, a layer of copal varnish is applied. When the whole is quite dry, this varnish is removed by alcohol. *Journal of the Chem. Soc., from Dingler's Polytech. Journal, ccxii.* 351.

Stones for Mosaic.—H. SEGER gives the following analysis of two mosaic stones of Spanish manufacture, and of great beauty and purity of tint. They were triangular plates 9 millimetres thick, apparently cast in moulds, as their edges were sharp. Their fracture resembled that of porcelain; they were unglazed:—

	Blue Stones.	Chocolate Brown Stones.
Silica	62·37	60·38
Alumina	23·17	21·89
Lime	0·98	1·23
Magnesia	traces	2·04
Potash	5·18	4·06
Peroxide of iron	0·96	7·72
Oxide of manganese	—	3·58
Oxide of zinc	6·61	—
Oxide of cobalt	0·54	—
Phosphoric acid	0·31	traces
	100·12	100·83

Probably these stones consisted of kaolin, felspar, and quartz, mixed with the following colouring matters:—For the blue tiles, smalt; for the brown ones, a ferruginous oxide of manganese, or a mixture of oxides of iron and manganese. Probably the zinc has some modifying influence on the shade of the blue mosaics. *Journal of the Chem. Soc. xii.* 1116, *from Dingler's Polytech. Journal, ccxii.* 255.

Cement for Porcelain.—Milk is coagulated by means of acetic acid, and the caseine thus formed well washed in water, and then dissolved in a cold saturated solution of borax: a clear solution is thus obtained which is superior to gum arabic in adhesive power, and is colourless. For porcelain, this liquid is mixed with finely-powdered quick-lime, and the resulting cement quickly brushed over the fractured surfaces, which are then bound together; the ware is then dried at a gentle heat. *Dingler's Polytech. Journal, ccxii.* 352.

Paper Pulp.—M. HENRY patents the use of hydrochloric acid instead of caustic soda, or other soda compounds, for the treatment of straw, jute, and other materials in the manufacture of paper pulp, so as to obtain a purified cellulose suitable for the purpose.

Indelible Ink.—J. G. TONGUE patents the preparation of a composition prepared by mixing well triturated carbon with an alkaline silicate (potash or soda), the following proportions answering well:—

Lamp black	1 part.
Syrupy silicate solution	12 „
Ammonia liquor	1 „
Distilled water	38 „

Varnish for Metals.—PECHADE patents the following varnish:—

Petroleum essence	1 kilog.
Boiled linseed-oil	500 grammes.

to be mixed cold. Metallic plates prepared for lithography, &c. are brushed over with this varnish (applied cold); when dried by heating it has a golden yellow tint. *Bulletin Soc. Chim. Paris, xxii.* 479.

Gutta-percha.—BAGEAU removes from gutta-percha its power of becoming sticky by heat, by vulcanizing it, and then employs the vulcanized gutta-percha for the construction of canvas and other textile matters, which are required to resist the action of moisture. *Bull. Soc. Chim. Paris, xxii.* 430.

Charcoal for Decolorizing.—J. MELSENS impregnates wood with a solution of calcic phosphate in hydrochloric acid, carbonizes in retorts, and finally lixiviates, in order to remove the calcic chloride. Charcoal produced in this way is said to be remarkably well adapted for decolorizing purposes. *Ber. D. Ch. G. vii.* 1540.

Causes of Fire.—Mice are as fond of wax vestas as of candles, and will frequently store them up in their holes if they obtain access to the place where the matches are kept. Many fires are doubtless due to the ignition, under the floors and behind the wainscotings of houses, of matches, conveyed there by this agency.

Nitro-glycerine.—MOWBRAY gives the following practical rules for the handling of nitro-glycerine, derived from his experience at the Hoosac tunnel:—

1. Handle with the greatest care, avoiding every possible jar or concussion, and be very careful, if any is spilled outside the can, to avoid striking it with or against any hard substance.
2. When in a solid state, thaw out by placing the cans in a vessel of warm water, never warmer than the wrist can bear, first pouring some of the warm water from the vessel into the can, and always removing the can or cans before adding more warm water to that in the vessel in which the cans are placed.
3. When filling cartridges hold them carefully over a tray about two feet by three, the bottom of which must be thoroughly covered with plaster of Paris, which latter must be replaced as rapidly as lightly saturated with the nitro-glycerine. Memorandum: plaster of Paris saturated with nitro-glycerine does not readily explode.
4. If necessary to store nitro-glycerine in a liquid state for any length of time, insert the cork loosely, and pour a pint of cold water in each can, which water must be frequently and carefully poured off and replaced with fresh cold water in warm weather, always taking care to retain the bladder under the cork. If ice can be procured, however, it is both safer and more desirable to congeal the nitro-glycerine and keep it in a solid state.
5. Use gutta percha funnels for filling water holes. Never tamp the drill holes, it is totally unnecessary and is pretty sure to kill the individual who does it.
6. Never use hot irons to warm the water, or for soldering the cans, both are sure to cause explosions.
7. Never sledge or drill in a hole or seam where nitro-glycerine has been spilled, without first firing an exploder to clear the place out.
8. Never pour nitro-glycerine into a hole, unless perfectly sure that the hole is sound and will hold water; if otherwise, always use a cartridge.
9. To obtain the best results, use drill holes always 6 ft. in depth, or over, fire with powerful exploders and well insulated wire, by electric battery and with simultaneous explosion.
10. After a blast, look carefully for any unexploded cartridges that may be laying around loose.
11. Allow none but the most careful, competent, and sober persons to handle or have charge of nitro-glycerine, and enforce rigid obedience to orders and compel the adoption of every precaution to prevent accidents or explosions.
12. Never use empty cans for other purposes, but transport them to a safe place, and destroy them by fire, or with a fuse and exploder.
13. Carefully examine the cans from time to time, and notice if any pin holes have been eaten through at the level of the nitro-glycerine therein. Should the presence of such holes be detected, procure new cans or stone jars, and place the contents of the unsound can therein, never loosing your hold of the upper portion of the unsound can, lest it break loose and trouble ensue.
14. When congealed, nitro-glycerine is absolutely safe; if possible, therefore, it should always be stored surrounded with ice, since explosion is impossible when in a solid state. *Iron, No. xcix. p.* 716.

To Polish Gold and Silver Lace.—Gold lace, spangles, clasps, knobs, &c. may be brushed over with the following composition—take

Shellac	1½ ounce.
Dragon's blood	½ drachm.
Turmeric root	½ „

and digest with strong alcohol, decanting the ruby-red coloured tincture thus obtained. After coating with this composition, a warm flat-iron is gently brushed over the objects, so as to heat them only very slightly. Gold embroidery can be similarly treated. Silver lace or embroidery may be dusted over with the following powder and well brushed. Take alabaster, and strongly ignite it, and whilst still hot place it in corn brandy; a white powder is thus obtained, which is fit for use after heating over the flame of a spirit lamp. It should be dusted on from a linen bag. *Dingler's Polytech. Journal, ccxii.* 353.

Metrical Notation.—In connection with the recent introduction of the metrical system of weights and measures, the German Ingenieur-Verein has addressed the Bundesrath on the subject of the system of notation to be used therewith. They consider that in the case of certain subordinate measures, the decametre, the decimetre, the quadrat decimetre, the cubic millimetre, the decagramme, the decigramme, and the centigramme, the use of literal exponents is supererogatory. In all others, and in the case of certain specific measures also, they

submit that a fixed notation would be desirable and easy to establish. They suggest that particular letters, in small roman type, should in these cases be affixed to the integral figures, over the decimal point where the latter is used, as hereunder :—

1 Kilometre or 1 ^{km}.0	= 1^{km}	1 Litre	= 1^{l}
1 Metre	= 1^{m}	1 Cubic centimetre	= 1^{cc}
1 Centimetre	= 1^{cm}	1 Ton	= 1^{t}
1 Millimetre	= 1^{mm}	1 Hectokilogramme	= 1^{hk}
1 Hectare	= 1^{ha}	1 Kilogramme	= 1^{k}
1 Are	= 1^{a}	1 Gramme	= 1^{g}
1 Quadratmetre	= 1^{qm}	1 Milligramme	= 1^{mg}
1 Quadratcentimetre	= 1^{qcm}	1 Metakilogramme	= 1^{mk}
1 Quadratmillimetre	= 1^{qmm}	1 Horse-power	= 1^{e}
1 Cubic metre	= 1^{cbm}	1 Atmosphere	= 1^{at}
1 Hectolitre	= 1^{hl}	1 Calorie	= 1^{c}

Zeitschrift des Vereines Deutscher Ingenieure, xviii.

Statistics of Manufacturing Establishments in France.—Statistical inquiries, instituted by the Ministry of Commerce, and just concluded, show that there are in France 123,000 manufacturing establishments, using a steam-power of 502,000 *chevaux-vapeur* (about 500,000 horse-power), and giving employment to about 800,000 hands. The Department of the Seine ranks first in point of productiveness, with, in round numbers, a manufacturing total of 1,690,000,000 francs, or one-fifth of the whole. The Department of the Nord, which ranks next, has a total of 700,000,000 ; the Rhône, 600,000,00 ; the Seine-Inférieure, 400,000,000 ; the Bouches de Rhône, 271,000,000 and the Loire, 224,000,000. The last departments on the list are Correze and Cantal, with totals of 5,500,000 and 3,500,000 francs respectively. The average for the whole of France is about 109,500,000 francs per department ; but this, as just shown, is very unequally distributed. *Revue Industrielle, 2nd Dec.* 1874.

Constant of Friction of Atmospheric Air.—To determine the relation subsisting between this constant and the temperature of the air, M. J. PULUJ uses a cylindrical jar communicating with a capillary tube and a manometer. The whole apparatus, the manometer excepted, is placed in a trough filled with water heated by three gas jets. The air in the jar becoming rarefied, the water ascends in one of the branches of the manometer. The time taken by the head of the column of water, when depressed by the introduction of the air, in passing one of the index points marked on the scale, is noted. Thirty-three experiments were thus made at temperatures between 1·1° and 91·2° centigrade. The constants of friction were deduced from the results thus obtained by Poiseulle's law ; and from these constants, by the method of least squares, was obtained the formula : $v = A + B\theta$, expressing the relation between the friction of the air and the temperature. The theoretic formula is : $v = v_0 (1 + a\theta)^{\frac{1}{2}}$, v being the absolute value of the constant of friction, and a the co-efficient of expansion of the air. Generally, if we put $v = v_0 (1 + a\theta)^n = v_0 + v_0 a n\theta = A + B\theta$, we shall have $A = v_0$; $n = \frac{B}{aA}$. The exact value of n calculated from the constants A and B is expressed by the equation : $n = 0{,}590{,}609 \pm 0{,}009{,}510$, according to experiments made at temperatures between 13·4° and 27·2° cent. It appears probable that, even at temperatures exceeding these temperatures, the potential exponent of the assumed absolute temperature would not exceed it by the fraction $\frac{2}{3}$; and that the formula : $v = v_0 (1 + at)^{\frac{2}{3}}$ would be an approximate expression of the relation subsisting between the friction of the air and the temperature. *Les Mondes, from Proceedings of Academy of Sciences of Vienna.*

Firing Explosives.—M. SARRAU has observed that the projective force of explosive substances varies sensibly according to the nature of the exploder. Dynamite, for instance, gives effects which vary from 1 to 10, according to the determination of its explosion in the first case by fire, and the last by mercury fulminate. That is, the force exerted by dynamite is tenfold less with an unsuitable exploder than with a suitable one. The same holds good for other substances, gunpowder acquiring a five-fold force when sympathetically kindled. *Revue Industrielle, 30th Dec.*, 1874.

Waste of Steam by the Injector.—OSCAR SCHRODER has been experimenting with the injector and a single-action pump gauged to the same delivery. He finds that the injector uses seven times more steam than the single-action pump ; and the proportion is even greater, relatively, with a double-action pump. For the supply of a reservoir placed 15 metres high, he found that for a delivery of 72·5 litres per minute the consumption of steam was twenty-two times greater with the injector than with a pump, and the injector only raised the water to 14° centigrade.

Wind-Pressure in Wind Instruments.—A good deal has been said at various times about the injurious effects of the forced expiration employed in performing upon wind instruments, but heretofore no attempts were made to determine the actual amount of pressure so produced. The results of some experiments on the subject were communicated to the Physical Society by Dr. Stone a few months ago. The experiments were of two kinds. In the first series, the extreme wind-pressure which could be supported by the muscles of the lips and throats of trained and untrained performers was measured by means of a water-gauge. Great differences of muscular power were indicated ; some untrained persons exhibiting this power in a very remarkable degree. About 6 ft. of water was the maximum that could be supported in a gauge tube of small (unspecified) diameter. It was found that a greater pressure could be exerted with a cupped mouthpiece, such as is used in most brass instruments, than with others. The majority of untrained performers could not support more than 3 ft. or 4 ft. of water in the gauge. The lip muscles invariably gave way before those of the throat were exhausted. In the second set of experiments, a small bent glass tube was inserted in the corner of the performer's mouth, and connected with the gauge by means of a flexible tube passed over his shoulder as he stood with his back to the gauge. Observations were repeatedly made on some of the most distinguished instrumental performers in England. A fair "mezzo-forte" note was used. In every case much greater pressure could have been produced by over-blowing, but the pressure exerted was sufficient to give an average orchestral note. The results shown by the gauge were as hereunder :—

	Lower notes.	Highest note.
Oboe	9 inches.	17 inches.
Clarionet	15 „	8 „
Bassoon	12 „	24 „
Horn	5 „	27 „
Cornet	10 „	34 „
Trumpet	12 „	33 „
Euphonium	3 „	40 „
Bombardone	3 „	36 „

Proceedings Physical Society of London, 1874.

Cone Anchor for Balloons.—M. J. CROCÉ-SPINELLI calls attention to a mooring-cone devised by M. Sivel as a safeguard in cases where balloons descend upon the water, which has been used with complete success in two recent descents in the Bay of Naples, and in the Sound near Elsinore. It consists of a hollow rectangular cone of waterproof canvas, with a diameter of 2 metres to 2·50 metres for a balloon of 2,000 cubic metres capacity. It is slung to the lower extremity of the guy-rope. When the balloon descends over water, the cone of course meets the water first, and fills. Its weight is then sufficient to overcome any ascensional effort of the balloon, which, in place of sinking to the surface to be buffetted by the wind and waves, is thus anchored at a safe height above it, and may be allowed to run before the wind until assistance come to hand. The weight of the cone when filled with water steadies the movements of the balloon, and the escape of gas is very small, as a uniform altitude being maintained, the atmospheric pressure on the balloon's surface is constant, and there are none of those incessant vertical oscillations which greatly contribute to the emission of the gas under ordinary circumstances. A line is attached to the apex of the cone, by which it can be reversed from the car, if desired. By thus emptying the cone and throwing out ballast at the same time, the balloon may be made to reascend. *L'Aéronaute, November*, 1874.

Noise in Carriages.—A correspondent of the undermentioned journal writes : "From their construction and mode of use, all carriages must necessarily be attended with noise in a greater or less degree ; in vehicles that have been long in use the noise is of a jingling nature, caused by some of the parts shaking themselves loose ; but in new carriages it is different, and, if possible, of a more disagreeable character. It appears as if the whole of the carriage was put into a state of tremor, which may be quite distinctly felt by either pressing the fect firmly to the carriage bottom, or the hand against the sides or top. In investigating the cause of this defect, it must be first considered in what style of carriages it is the most noticeable. First, it will not be often heard in carriages hung with leather braces upon C springs, nor yet upon any ordinary hung two-wheel carriages. It is occasionally heard in light four-wheel work, as dog-carts, especially if the under-carriage part be con-

structed wholly of iron, and it is most often found in close carriages, as broughams, or covered waggonettes mounted upon elliptic springs. In two carriages constructed as near alike as possible, with material of same size and quality, and internal arrangements and fittings alike, it seems remarkable that one should have this noise and the other be without it. The probable explanation is, that all parts of a new carriage are firm and tight, thereby giving off a ringing sound when struck. The wheels, axles, springs, and body have each their own particular ring, and upon the principles of convection and sympathy of sound this defect may be explained. The concussions the wheel meets with are conveyed by the axle to the springs, and from thence to the body, and so cause the noise. If the sound of the wheels be in unison with that of the axle, springs, and the resonance of the body, this vibration will be increased and the whole carriage be put into a state of tremor. But, it may be asked, why is this not the case in every carriage so hung, but only in some particular ones? This may be explained upon acoustical principles. If the ring of the wheels and the resonance of the body be unlike or not in unison, the one vibration will counteract that of the other, and intervals of silence recur at greater or less intervals according as their vibrations are unlike. If also the springs, acting as the connecting medium between the wheels and body, be different in tone, the tremor will be subdued to a minimum. The ring of the wheels alone would be comparatively small, but when connected, by a sounding medium, with so large a resonant mass as a body has, it becomes a powerful sound. The common fiddle affords a familiar example of this; the vibration of the strings under the action of the bow would in themselves be quite feeble were it not for the resonance of the body of the fiddle, which they are directly connected with.

If the foregoing be the correct explanation, which it reasonably seems to be, then the readiest method of remedying the evil will be either to create a difference between the quality of the ring of the wheels and that of the body, or else to interpose between them as perfect a non-conducting medium as possible.

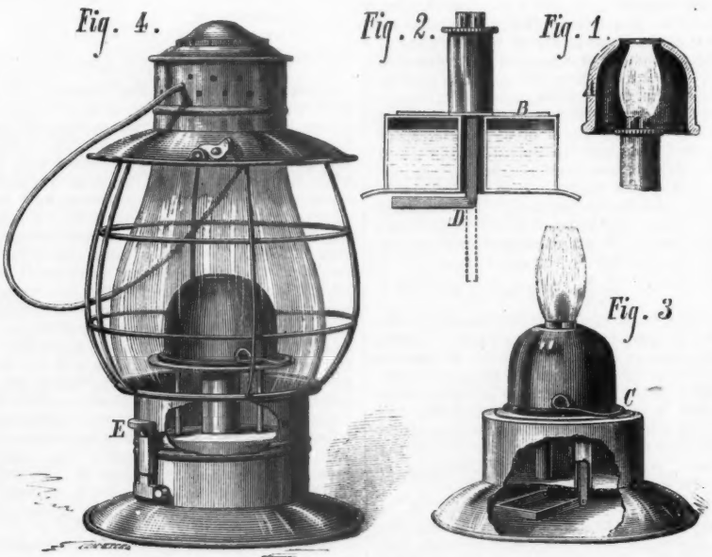
The carriage hung on leather braces, or that connected to wooden shafts being found without this noise, show, to a certain extent, that a difference in the quality of the connection has something to do with its remedy. If for elliptic springs be substituted a spring admitting of leather robins at each end as a connection with the body, a substance is thus placed, through which sound can travel with difficulty, and so tend greatly to deaden the noise heard in the body. India-rubber is a substance which might be used in such cases, only there has yet to appear a way that it can be used in springs to advantage; all that have been tried yet have about them some grave defect. The above has been tried, and as far as could be tested seems to answer as a means of reducing the unpleasant vibration, if not wholly removing it." *Carriage Builder's Gazette, Dec.* 1874.

Price of Labour in Russia.—A Report, furnished by the Municipal Delegation of St. Petersburg, supplies some particulars of the fluctuations in the price of labour in that capital during the last twenty years.

The following were the average rates of daily wages paid in the month of May in each of the undermentioned years, 1853, 1863, 1873:—

	1853.	1863.	1873.
Excavators . . .	50 kopecks.	75 kopecks.	90 kopecks.
Masons and stone-cutters	80 „	115 „	110 „
House painters . .	90 „	95 „	90 „
Paviors	75 „	85 „	90 „
Sawyers	70 „	75 „	80 „
Labourers . . .	50 „	75 „	80 „
Joiners	90 „	105 „	115 „
Plasterers . . .	80 „	95 „	100 „
Carpenters . . .	80 „	95 „	110 „

It will be seen that in most cases the advance was greater between 1853 and 1863 than between 1863 and 1873, and that the wages of labourers have risen in higher proportion than those of skilled mechanics. Thus the wages of excavators have risen 80 per cent. in the course of twenty years, whilst those of house painters have remained almost stationary. *Moniteur Industriel Belge, from Russian Gazette de l'Académie.*



THE QUICK SIGNAL RAILROAD LANTERN.

THE "Scientific American" says—"We have lately had brought to our attention a new form of railway lantern. It is an invention which absolutely insures the carrying of a red light by every individual in whose hands is the common lantern. In other words, it is an arrangement whereby, in a fraction of a second, a white may be changed to a ruby light, and *vice versâ*, and this by mechanism so simple that failure is practically impossible. The details of construction will be readily understood from the above engraving.

A, in fig. 1, is an inverted cup of ruby glass surrounding the flame of the ordinary lamp, and, of course, having an opening above for the escape of smoke, &c. This cup rests upon a small circular metal platform, B, fig. 2, and is held in place by a wire spring, C, fig. 3, catching on its rim. The platform, B, is movable, and has an aperture in its centre for the wick tube. To its under side are attached rods which pass down in short tubes extending through the body of the lamp, as shown in section in figs. 2 and 3. To the extremity of the rods is hinged a prolongation or handle, D, the ends of which are connected. Ordinarily, when the piece, D, is folded over against the bottom of the lamp, the upper extremity of the wick tube extends a

little above the ruby glass envelope, as represented in fig. 3. The lantern is then a simple white light. If now it be desired to show a red illumination suddenly, the operator merely grasps the piece, D, bends it straight, and pushes it up. He thereby raises the ruby glass so as to cause it to inclose the flame completely, the parts become as shown in fig. 1, and the danger signal is ready for instant service. There is one more point of construction which requires notice before passing to a more careful consideration of advantages, and that is the locking mechanism, at E, fig. 4, which holds the lamp firmly in the body of the lantern. This is an ingenious little automatic device, the subject, by the way, of a separate patent, and consists merely of a bolt, having a T head at its lower extremity. The projection on the lamp is slipped into a right-angled slot on the cylinder, first up, then to the right. As it is pushed upward it raises the bolt, then, on being turned, slides along its lower side, until the extremity of the horizontal part of the slot is reached. The bolt by this time is cleared, and, being no longer supported by the lug, falls back by its own weight, and locks the latter in place. The advantage of this is that the lamp can be inserted in an instant by feeling alone; and once caught, it is rigidly secured.

It is stated that the red light thus arranged gives a much greater illumination, one of three times the intensity of the common ruby lantern. This is probable, from the fact that the clear glass shade serves to diffuse and reflect the rays while not obstructing them; whereas, in the large shade of entirely dark glass, little more than the strong direct rays from the flame reach the eye, the others being absorbed in traversing the coloured medium. At a certain distance, for instance, where simply a dot of red flame is seen in the ordinary lantern, this device would appear as a ball of red fire.

The fittings and construction of the lanterns generally are of improved description, and are of durable and strong material. The probabilities of breaking the red glass are, of course, much less than those of injuring the large red shade of the common form of signal; while, in the event of such happening, the small cup can, necessarily, be much more cheaply replaced.

The inventor informs us that the invention has been ordered for use by every railroad to the managers of which its advantages have been exhibited. In order to afford a full examination, a single lantern will be sent by express, as a sample, to every road desiring to test it in actual employment."

It is claimed that the use of this lantern will prove a source of economy, about three of the new lanterns doing the duty of four of the old ones; to this is coupled the assertion that it is more efficient, and that a danger signal is always to hand when wanted.

ON THE BITUMINOUS DEPOSITS OF THE VALLEY OF THE PESCARA, S. ITALY.

By Dr. R. Carter Moffat, Professor of Chemistry, Glasgow; Italian Gold Medallist for Industrial Investigations and Discoveries.

THE vast deposits of bituminous limestone situated in the valley of the Pescara are of great commercial value and can be easily and cheaply worked. The district is little known, but in a few years I believe several companies will be at active work in excavating the ore and extracting the bitumen. I spent five weeks inspecting the district professionally last spring, and carried out experiments to ascertain the commercial value of the minerals and the best modes of extracting the bitumen, and also the manufacture of oil direct from them.

The bituminous rocks of Rocca Morici, San Giorgio, Aqua Fredda, Santa Maria, Farà San Martino, Santa Liberata, Fonticelli, Chiuse, Arrenario, Fondocello, Crocifisso, and Romana, are all in the province of Chieti, and for the most part are found in the valley of the Pescara. A railway runs in the valley within a few miles of the deposits connecting with important lines and ports.

Labour is abundant at less than 9*d.* per day, while wood and peat for fuel are to be had at about 8*s.* per ton for wood and 5*s.* for peat delivered at most of the mines, as the deposits are termed.

The limestone with which the bitumen is impregnated varies in character and composition in several of the mines. While the mineral is always calcareous, it is in the generality of places magnesian limestone, but in a few of them it is gypsum and selenite. The amount of bitumen in the ores varies from a few per cent. to 50, and it becomes a matter of great importance in selecting a mine (which is to be had for a merely nominal sum) to pay special attention to the experimental determination of the amount of bitumen, as derived from a great many trials. Much experience is required to know by sight a very good from a very moderate sample. I have seen many samples apparently very rich in bitumen yield but little when tried.

The best mode of extracting it is by "Bennie's patent retort for manufacturing refined bitumen," which allows of a continuous and uninterrupted working.

Messrs. Geo. Bennie & Co., Kinning Park Foundry, Glasgow, are well-known and extensive manufacturers of oil-work plant, and indeed make it a specialty, and do little else. The senior partner, Mr. Geo. Bennie, has frequently visited the bituminous deposits, and has, after minutely studying the matter, devised and patented this apparatus in Italy, which certainly supersedes all other kinds at present used from its simplicity, cheapness, effective and continuous working.

The bitumen so produced is practically pure, and can be sold at present in London for £6 per ton, while it costs only £1 2*s.* 6*d.* per ton to produce it at the mine. One ton of mineral can be raised at the rate of 1*s.* 6*d.*

When the bitumen is distilled, one ton yields 100 gallons of oil of specific gravity 955, giving 25 per cent. burning oil of excellent quality and 62 per cent. heavy lubricating oil of 950 gravity.

Crude oil is sold in Italy at 8*d.* per gallon, and burning oil is readily bought up wholesale at 2*s.* per gallon.

There is a very high rate of import duty on burning oil in Italy, 10*d.* per gallon being levied on all burning oil imported. Consequently this oil commands more than double the price that it does in this country.

To capitalists the working of these deposits for bitumen and oil hold out, under judicious and intelligent management, the surest prospect of excellent and highly profitable investment.

In my opinion it cannot be long before the great mineral wealth of the district is turned to good account.

DESCRIPTION OF THE STRAIGHTENING OF A BRICK CHIMNEY-SHAFT, AT THE ROYAL ARSENAL, WOOLWICH.[1]

THIS chimney-shaft, which formed part of the Gas Works in the Royal Arsenal, Woolwich, was built in the year 1860. The ground plan is a square; and the height 100 ft. Borings taken prior to its erection showed that the subsoil consisted of clay resting on a bed of peat, situated at a considerable depth below the surface of the ground.

At the time of its erection a pile foundation was considered unnecessary; and the shape was built on a mass of blue lias lime concrete, 30 ft. square and 8 ft. thick.

Soon after the chimney was completed, it was observed to be inclining from the perpendicular; and, in 1861 it was leaning over 19 in. to the south side, and 24½ in. to the west. Observations were taken with a theodolite, and repeated at intervals up to the middle of the year 1873, when it was found that the inclination of the shaft had increased to 33⅝ in. towards the south and 42½ in. towards the west side. The increase of the inclination was not uniform in its rate, but became more rapid between 1871 and 1873.

Consequently, although the limit of safety—72 in. of inclination—had not been reached, it was decided to attempt to straighten, in place of rebuilding, the shaft. In the absence of a careful examination of the foundations, which would have been a costly undertaking, it is difficult to assign the cause of their failure; but it is thought quite possible that the peat may have become compressed by the weight of the chimney, which is estimated at 720 tons, and so have caused the concrete to crack.

The operation of straightening the shaft was carried out, under the superintendence of Lieut.-Colonel Scratchley, Royal Engineers, Inspector of Works, Manufacturing Departments, and Lieut. Watson, Royal Engineers, by Mr. Ralph Hall, of 126, North Frederick Street, Glasgow, a well-known "Steeple-Jack"

[1] Abstracted from "Papers on Subjects relating to the Duties of the Corps of Royal Engineers." 1874.

of great experience in all matters relating to the repair of chimney-shafts, the fixing and replacing of their caps, fitting lightning conductors, etc. etc.

The price paid for the work was £50, a very moderate one when it is remembered that the cost of removing the old shaft and building a new one was estimated at £650. The operation was a very simple one, suited to shafts of any height, and, apparently, unattended with any risk; but the operators must possess great coolness and experience.

After consultation with Mr. Hall, it was determined to cut out the brickwork at the top of the chimney-base, where its thickness was 27 in. through the angles, and 22½ in. at the sides, exclusive of the fire-brick lining to the flue, which, as it was bulging, had to be removed.

An old steam-boiler tube was erected to serve the purpose of a temporary chimney; and a scaffold consisting of a single plank resting on poles having been constructed round the shaft at a convenient height from the ground, Mr. Hall, assisted by one labourer only, commenced operations by taking out two complete courses of bricks throughout the entire thickness of the chimney, beginning just clear of one of the angles and working round three sides and three other angles. No bricks were removed on the fourth side and about the first-mentioned angle, because when the chimney was straightened these parts would have about their proper level.

As the bricks were taken out, two courses at a time and two bricks wide, they were replaced by two courses of bricks of less but varying thickness, set in sand mixed with just sufficient lime to make it bind, and to prevent it from falling out bodily when the sawing process, to be hereafter described, commenced. On two sides and about two of the angles, where the inclination of the shaft was greatest, thinner bricks were employed than about the third angle, but they were set in a much thicker layer of sand. This part of the operation occupied Mr. Hall and his man about eight working days.

The straightening of the chimney was then begun by the very gradual removal of the layers of sand and courses of brick just put in. For the former, an iron cross-cut saw, $\frac{1}{16}$ in. in thickness, with very coarse teeth, was used, Mr. Hall working on the outside of the chimney and his man on the inside. As the sand on the upper course of bricks was removed the shaft gradually settled down on them, turning on the untouched angle as a fulcrum. The upper course was then taken out, two bricks wide at a time, and replaced by thinner bricks or tiles, set in sand as before. The sawing was then resumed, and the sand worked out; the tiles were next removed, and replaced by sand only, which in turn was sawed out.

As the process continued the shaft came over imperceptibly, until it had reached a perpendicular position, when it was found that the untouched angle had risen a quarter of an inch, and the three other angles had fallen 5½ in., 3 in., and 3 in. Observations with the theodolite showed that the shaft still inclined 4 in. to the west. It was impossible to get it truly vertical, as the chimney had gone over diagonally.

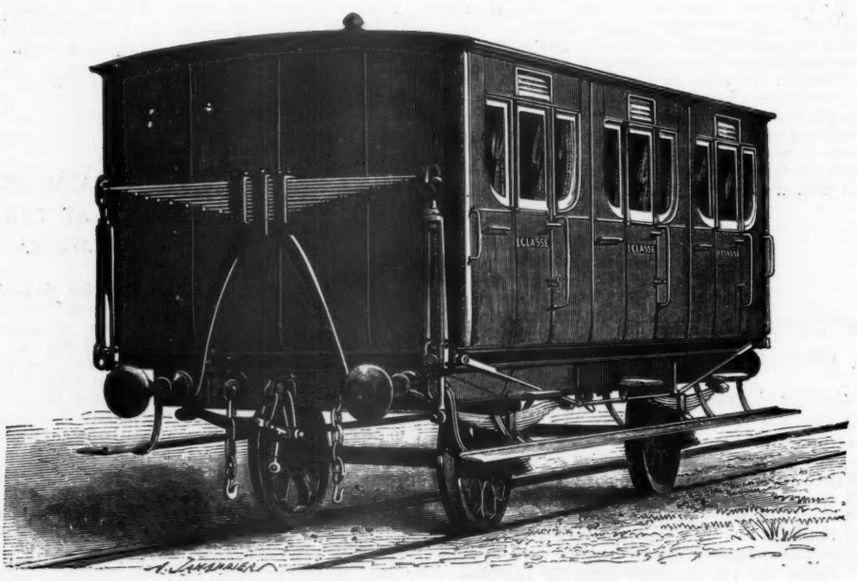
The concluding part of the operation was to replace the remaining bricks and tiles with bricks, cut to suit the wedge-shaped opening left, and set in cement.

The work was completed in three weeks.

To ensure success in like operations, the following points, we are told, must be carefully attended to:

1st. The sand and bricks must be very carefully packed, so as to leave as little as possible of the weight of the shaft unsupported at any one time.

2nd. The packing should be removed very gradually, so as to prevent the shaft resuming the perpendicular too rapidly.



THE GIFFARD RAILWAY CARRIAGE.

THE accompanying engraving, taken from a photograph, shows how Mr. Henry Giffard has solved the difficult problem he was studying, by isolating the body of the carriage containing the passengers, and rendering it quite independent of the frame, and transforming it as it were into a sort of hammock. But it was also necessary to avoid any sensible swinging motion, and this could only be obtained by a cleverly combined system of friction. Mr. Giffard's combination of springs is composed of large metallic plates placed one above the other, and between which metallic bars are fixed so as to isolate them from each other. This disposition is repeated at each end of the carriage. The body of the carriage is thus suspended to the springs by means of two pieces of metal

During the experiments lately conducted at Paris and at Lille, it was found that the rocking or swinging motion, that is to say the horizontal lateral motion, which is so painful and fatiguing to travellers, was entirely suppressed. There only remained a slight vertical oscillation, which could be obviated by tightening up the suspending screws. The travellers were as quietly seated in the carriage as in an arm-chair at home; they could read, write, and work comfortably, and usefully employ the long hours usually lost during an extended journey.

Mr. Giffard's carriage is more expensive than the ordinary cars, and it is of very considerable weight; but it will not be impossible to employ it first as a supplementary class, of which the places would be of a higher price. It appears certain this system will come into favour with the public.

ON COLOURING ARCHITECTURAL AND MECHANICAL DRAWINGS.

IN our last paper we considered all the preliminary points of selection of subject, of paper, and of colours, &c., and instructed the student how to strain his paper; we may now proceed to the actual question of applying the colours to the finished and inked-in line drawing. The shading, as already stated, should be done first, and on the skill and care with which it is executed depends much of the success of the picture. In landscape water-colouring a slight error with the brush can be worked over, and its effects erased by careful manipulation, so that what threatened to be a blemish is converted into a feature; but this cannot be done in shading a shaft or a pillar, consequently the artist working at these last must devote himself for the time being heart and soul to the work; if his thoughts wander at a critical moment, irreparable mischief will result.

In shading, two brushes are necessary, as well as a tumbler of perfectly clean pure water; a piece of white or buff blotting paper is also needful, the cheap pink stuff is not suitable, being too fluffy, "and apt to fill the brush rubbed on it with hairs." Part of the blotting paper should be kept wet, because the softener is rubbed on it, not to dry the latter, but only to draw the colour out of it. Shading, of all other operations about colouring, is the most trying to the patience; as many as four, five, or even more coats, have often to be laid on, each stippled smooth, and left till quite dry and hard before the next is applied; the best tint for shading is plain Indian ink, with the least trace of Paine's grey through it, this last making the ink more amenable to the softener. Mr. Burchett, Head Master of the School of Art at South Kensington, recommends a trace of crimson lake, and very likely for warm shadows in landscape such addition may be advisable, but its advantage in geometrical drawings is, in the author's opinion, doubtful. The colour should be mixed rather strong in one saucer; a brushful then to be transferred to another saucer, and well thinned down with water; a brushful of this again to be transferred to and thinned in another saucer; this last ought, in fact, to be little more than tinted water. The beginner must always remember that it is a characteristic of all his class to grind and apply colour in a state resembling cream for thickness, with results of a sort more remarkable than pleasing; students will only cure themselves of this habit by recollecting that too weak a tint can be deepened at pleasure, but a tint too deep can never properly be reduced; clever adepts, indeed, will wash with sponge, &c.; but it may be taken as an axiom, that artists clever enough to wash colour out without smudging their picture, will rarely or never make the original mistake. The artist having all ready, takes some colour in his brush, filling it to an extent proportionate to the extent of the surface he has to colour over; and here we must point out another matter: it has been stated in our last that colouring a picture is one large operation compounded of a multitude of very little ones, no single one of which must be overlooked or neglected; one of them is the degree to which the brush is filled; it is quite true that the size of the brush should be suited to the work in progress, but as a rule the artist will find a moderately large brush the safest for all work, the brush being more or less full of colour in proportion to the work to be done. If too small a brush is used, then it must be either too full at first or not full enough at the last, leading thus inevitably to inequality of tint. The charge of colour in a brush may be regulated in either of three ways—first, by the application of blotting paper; secondly, by rubbing against the edge of the saucer, which in a sense squeezes the colour out; and thirdly, by the best of all ways, viz. by filling the brush well with colour, and then jerking the arm and hand holding it out behind the artist, the superfluous colour will thus be thrown from the brush to an extent proportionate to the force of the jerk, in degrees varying from leaving the brush still nearly fully charged, up to an almost dry state, and the experience and judgment of the artist will speedily instruct him as to the best charge to keep in his brush for each individual bit of work.

Having charged his brush with the weakest tint of shading colour, the artist must lay on a band or strip of colour along the dark side that is to be of the shaft or column, making it about one-third of the entire diameter of the object in width; if the thing be not too long, the band can be done at one operation, which is always desirable, as it diminishes the risk of an unsightly joint in the colouring. The tint being laid on equally, the softener, previously damped to such an extent as neither to impart water to the tint already put on, nor yet to soak any tint up, must be rapidly and skilfully passed along the wet edge of the colour. If the brush softener be the right degree of dampness, it will change a little of its own moisture for the colour tint on the paper, making, in fact, a splice between brush and tint. The former must now be worked along the edge of the band quickly and carefully, and as the colour softens off under its influence, it must be worked back towards the centre of the diameter of the object being shaded. It must not be worked back too fast, otherwise the colour will not follow, and if it do not follow, it tends to shrink back and dry in a hard line, which if once formed takes unheard-of labour to stipple out. If the softener seems to have too much colour left after getting a certain distance towards the centre, it must be laid to the wet blotting paper, and turned to and fro till some of the colour is taken out of it; then the softening must proceed again, if necessary, resort being had to the blotting paper as often as requisite, till the tint of shading becomes merged in by degrees with the pure white paper. Should any inequality of tint show itself, it must not now be touched on any account; such a course would only make bad a thousand times worse. It must just be let to dry thoroughly, and then it may be stippled. As this term may not be familiar to some of our readers, we may say that it is an operation closely resembling "tickling," as, for example, when two children wager, one that it will not scratch or rub its lip or ear while its companion touches such places gently with a brush or feather. This operation, as regards its effect in softening and smoothing a coarse bit of shading, is quite beyond a paper description, nothing but experience and skill will make its good uses evident or clear.

As each coat of shading must be quite dry before the next is put on, three or more pieces of the picture must be proceeding at the same time, as each has thus the time to dry before its turn comes round again. The second coat must be a little stronger than the first, because the idea that successive coats of a single original tint will darken or deepen the colour is altogether fallacious; in flat, moderately deep tints, the second coat of the same mixture may slightly deepen the tint by thoroughly soaking the pores of the paper, but that is all, and no subsequent coat of that tint will strengthen the colour on the paper. The second coat is to be treated in all respects like the first, save only that as the darkest shadow does not fall on the line of the pillar, but a little thought removed from it, owing to a sort of reflected light intervening, the colour must not be washed up to the line, but kept from it a little, and softened down just as in the main shading. The successive coats of shading must thus be worked on till the last is little more than a very dark line. When this is quite dry, the board must be turned round, and a little faint line of shading be laid on the other defining line of the object, and softened off. This is a sort of reflected shadow, answering to the reflected light at the dark side of the pillar, &c.

After this operation is complete, the tint denoting the material, such as for stone, steel, iron, &c., must be put on, and must be put on just as if the object were not shaded at all. This tint ought not strictly to be put on till the day after the shading was done, so as to let it dry and harden, and even then care is needed in working the tint of blue, &c., up into the light, that the shading do not work with and smear it. Shading with Prussian blue, too, is a most critical job, especially on spongy paper, for this reason, that the colour nicely paled off, so as to leave a light line of pure white, will presently be found one deep and flat tint, owing to the subtle soaking of this most rebellious and destructive colour, tortoise-like along through the damp pores of the paper. The only preventive is to watch and take up the intrusive colour with a brush whenever it appears; and besides, to shade the tint paler than it ought really to be, and trust to this soaking up to make the tint about right. All this, of course, demands a certain degree of skill and experience; but yet, also, forewarned is forearmed. Some artists shade and tint very lightly, and where coloured drawings are made in English offices, the practice is rather to tint than to colour. On the Continent, colours are much more freely used than in Great Britain. Drawings meant for framing ought, however, to be shaded well and strongly, and the colours made moderately lively, because such pictures often fade a good deal; and thus, one that when new "stared" a little too much, in a twelvemonth has toned down into a nice picture.

Now as regards shadows; these ought to be most carefully put in correctly to the shape they would have in nature. A part of the instruction in Art Schools is the projection of shadows, and a most essential study it is to those who mean to be artists in the real sense of the word. Of course, in the preparation of a picture, all the geometrical lines, ordinates, &c., need not, and indeed could not well be put down, but when once the student has quite mastered the science, he will know of himself the form of outline the shadow of a given object will cast, and work it in accordingly. The outline of the shadow had best be very faintly

defined with the most imaginary of pencil lines; the shadow must then be put on, and although of course of a flat tint, the artist must watch the edge of the colour, and just as it is stiffening into a hard line, sweep it dexterously with a softener. Another wonderfully softening thing to do, is, especially if the shadow be a large one, to put on a little strong shadow tint close up to the flanch, capital, or other shadow thrower, and soften it off into the rest of the shadow.

The body tints now present themselves for consideration, and they too, while not so difficult to work with a brush as the shading, demand much taste and judgment in their application, and the best shaded and shadowed drawing in the world may be quite spoilt by lack of either on the part of the artist. In landscape, the artist has a thousand and one means of making each feature in the picture duly distinct; but in machinery the case is different; the number of parts is often great which are all to be in one colour, hence it is no easy task to make a clear and attractive picture under such conditions; the thing can be done, however. First, as regards the difficulty attending the colouring of a variety of fittings, in a given machine, all of them of the same material—cast iron, say,—well, a certain tint or colour must always be used. Very good. What says custom? A neutral grey for such metal. A mere dauber of paper will mix a saucer of Paine's grey or neutral tint, and colour everything—far from or near to the eye, big and needing but pale tints, little and needing prominence and strong colour—alike, and produce a picture neither pleasing in an artistic point of view, nor good in an engineering one, owing to its indistinctness. The true artist and workman reasons thus:—"As long as I use a grey or neutral tint, cast iron is understood; but in the first place I can use one shade in different strengths—this will help to give good effects, and I also can mix easily half a dozen different tints of grey, no two alike, and yet all greys." Well, if the variety in tints and in shades be worked with judgement, excellent effects will be produced; but at the same time the artist must respect the unities of his picture; thus, if on the elevation he colour a certain plummer block, say, in grey of a particular tint, then the same plummer block on the plan must be the like tint, though for pictorial reasons he may use a stronger or weaker shade of that tint. Landscape painters depict objects in their foregrounds stronger than at the horizon, because they deal with distances of miles; the geometrical artist has only distances of inches and feet to deal with, and consequently his best effects will be secured by making those parts farthest from the eye the darkest, tinting others as they come nearer in fainter colours, the dark objects behind throwing into relief those in front.

The author in concluding these hints on colouring mechanical drawings, does not profess to have treated the subject exhaustively; his remarks have been put forward to lead the student on to the study of able works on this and cognate subjects written by various eminent authors, and he trusts that these remarks and hints will help his student readers over difficulties he had much trouble in overcoming himself.

CHARCOAL AND WATER FILTERS.

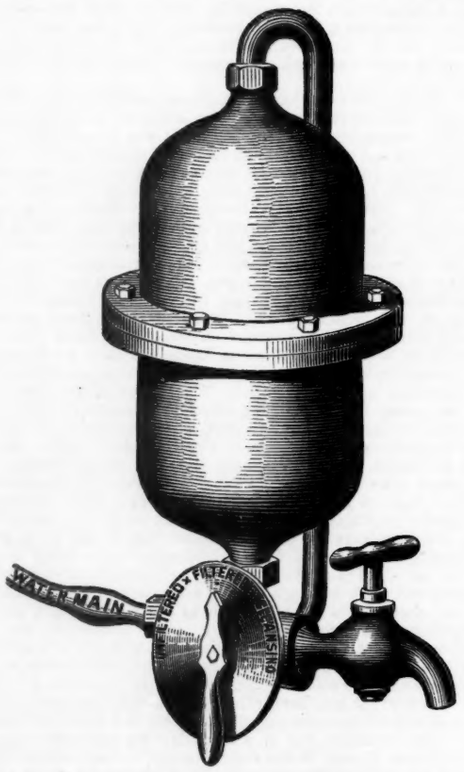
By A. Tolhausen Partington, C.E.

AMONGST the sanitary applications of chemistry, there is to our mind no other substance which rightly enjoys such high, well-earned reputation as is the case with *charcoal*. Not only in hygienic matters, such as its application in purifying the air either in the form of a disinfectant, or direct for medical purposes, but also in a variety of other ways has charcoal proved itself eminently successful both in the arts and manufactures.

As any residue or solid product left by the incomplete combustion of any organic matter is accepted to come under the meaning of "charcoal," the sense of this word is ambiguous, hence arises its limitation by a quantity of terms, such as animal or vegetable charcoal, or again, by more specific technical terms, such as bone-charcoal, box-charcoal, cone-charcoal, turf-charcoal, &c., which show at once from what matter the residue has been deposited.

Charcoals, from whatever source they are drawn, have certain properties in common, varying, however, in their intensities. One of the chief characteristics of charcoal is its porosity. This is certainly a property common to other bodies besides, although in this respect many facts have yet to be explained; for instance, the most minute examination of glass, of many crystals, or of fluids, do not show the least sign of porosity, still we know that light can penetrate through the former, and that the latter do absorb gases. Still, it is assumed that charcoal having an extremely porous character, thus receives its power of absorbing gases in large quantities by being able to present an inconceivable amount of surface. As it further contains rather more than eight times its bulk in oxygen, the deadly emanations given off by decomposing matter or other gases are brought into intimate contact with the condensed oxygen, and as a result, that which perhaps an instant before would have proved most hurtful if breathed, becomes now almost entirely resolved into comparatively harmless combinations.[1] This theory is supported by the fact that putrefying animal matter may be covered to a depth of a few inches, and no smell will be found to proceed from it.

The Swiss savant Théodore de Saussure,[2] who devoted a portion of his life to the investigation of charcoals derived from



various sources, found that box charcoal possessed this absorbing property in the highest degree, and according to this authority one volume of box charcoal condensed

90	volumes of	ammonia gas.
65	„	sulphurous acid gas.
35	„	carbonic acid gas.
9·42	„	oxide of carbon gas.
9·25	„	oxygen gas.
7·50	„	azote gas.
1·75	„	hydrogen gas.

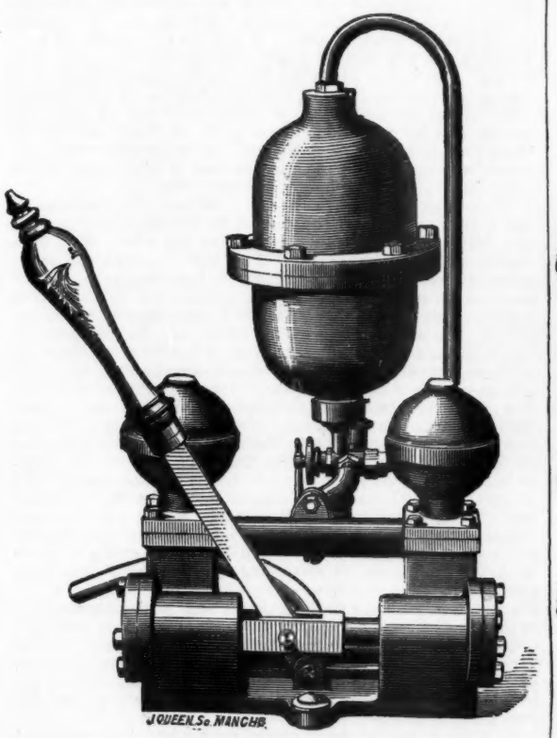
The application of allowing the air to pass over trays of charcoal in hospitals where a considerable amount of fœtid animal matter is exhaled, is due to this absorbing property of charcoal. Its uses as a dentifrice, as a respirator, or for other domestic purposes, are well known, though comparatively little practised.

A property of no less importance is the power charcoal possesses of replenishing its supply of oxygen from the surrounding atmosphere. Were this not so, it is evident that with its great absorbing avidity, a point would soon be reached at which its own oxygen would be exhausted, and as a consequence the process of combustion would cease to have any effect on fœtid gases or other deleterious substances. Now this is a

[1] Dr. Watson's theory.

[2] Died 1845.

cardinal point which charcoal enjoys over other disinfectants, as to ensure the success of the latter frequent replacements or replenishings must be applied. Charcoal, on the other hand, self-replenishing itself from the oxygen contained in the atmosphere, is ever ready not only to absorb recurring noxious gases, and to destroy them, but is also prepared to accept more and more. Whereas other disinfectants seem to owe their action to the volatile condition of their particles, somewhat similar to perfumes, in regard to their divisibility, charcoal is an inodorous substance, and consequently has not the strong smell of chloride of lime, and such like. Lastly, as a deodorizer, by means of a very little quantity of charcoal the strong smells of musk or of assa fœtida might be entirely neutralized. This is the more astonishing when we remember that it is a customary thing in shipping the latter, to hang it in sacks on the top of the vessel's masts in order to prevent it from imparting its smell to the remaining cargo; and such is the divisibility of this assa fœtida that Kreil calculated that one cubic foot of this substance could furnish thirty-eight trillions of sensitive parts; the divisibility of musk has been calculated to equal three hundred and twenty



quadrillions of parts to the grain weight, each of which parts can be detected by our nasal organ![1]

Another curious phenomenon of charcoal is that it can either be used as a preservative or a destructive agent. The processes of charring the ends of wooden stumps such as for fences or telegraph poles, coffins, or water tanks are examples of its preservative nature, which in the last instance is further increased by not only preserving the wood itself, but also by keeping the water therein contained, fresh and sweet, which is an exceedingly valuable receipt on board vessels bound for long voyages. Its destructive property consists in its easy adaptation to the generating of carbonic acid gas so often used for suicidal purposes, but even here it can be converted into a preservative agent in the quenching of flame or fire. Its power of preserving all the valuable constituents of animal excrements is at present well known, but strange to say, little appreciated.

Another singular and important characteristic of charcoal is in its taking up the colour or taste of various substances. Its property of discolouring does not exist to the same degree in all kinds of charcoal, but is dependent on the affinity of the coloured matter for carbon. Thus vegetable charcoal is in this respect less efficient than animal charcoal, and even in the latter great differences exist. The charcoal obtained from the calcining of bones is best suited to this purpose. The verification of this statement is easily tested. Carmine or indigo are both soluble in water. Two grains of carmine will colour twenty pounds, or one drop of indigo will dye five hundred cubic inches of water. These examples show how even the minute presence of either carmine or indigo is indicated in the colour of water; but still, this toning disappears if the water is allowed to filter through charcoal.

This observation has become the purpose of its important application in the arts, such as for the refining of syrups, of sugar, of oils, and for various other manufacturing purposes. On this very property is founded, in large cities, the practice of clarifying waters chiefly used for domestic purposes. Yet, with all the care and ingenuity displayed by the officials of waterworks, it is a patent fact and dread to every householder, that his household water-supply is not as pure as when it leaves the company's reservoirs. The causes of this are obvious—the long passage

through the mains; the injurious effects of the leaden pipes on soft water; or again, the overflow pipe leading to the drains gives the access of noxious gases to the cistern, and these causes all contribute to render the house-water impure, in certain cases even poisonous.

As a remedy, filters for domestic use have been applied to private houses, but their adoption has been prevented in large manufacturing concerns, where clean fresh water is required, such as in print, dye, bleach or paper works, breweries, hospitals, public buildings, &c., from their not being able to filter sufficiently rapid. These filters, which mostly owe their action to the presence of charcoal, have been greatly improved of late years, and one is now before the public that will filter water as rapidly as it is supplied by the water-mains, and as it can be attached to the latter it requires no filling, as ordinary filters do. From this it is evident that for large houses and public institutions they can be fitted on the water-main in a cellar, and will supply filtered water through all the ordinary taps in the building. Another great feature is that they are self-cleansing, and their purifying powers will continue unimpaired for years. Their action will be understood by referring to the three engravings given above.

The cylindrical body of this apparatus, known as "the Patent High-pressure Self-cleansing Filter," contains fourteen beds of charcoal, varying in coarseness, but finest towards the middle layer. These beds are kept in their place by perforated iron plates The supply of water is regulated by the hand on the dial-plate,

[1] Mousson's "Physik auf Grundlage der Erfahrung." Zurich.
[2] Baumgartner and Ettingshausen, "Naturlehre." Vienna.

on which three points are indicated:—unfiltered, filtered, and cleansing; and according as the hand of the dial is placed, the water entering in by the main can be allowed to pass off the tap shown in the first figure, either in the form of unfiltered or filtered water, or be made to cleanse the filter. This hand works a three-way cock placed behind the dial-plate and underneath the filter. As the hand of the dial is placed in the figure, the water entering in by the main is forced by its own pressure to traverse the beds of charcoal before mentioned, and the water thus becomes purified. The cleansed water is further forced up the siphon pipe which communicates with the tap, where the water can be drawn off for domestic use. In case unfiltered water is required, and the hand of the dial set accordingly, the water passes direct from the main pipe to the tap; the self-cleansing process is obtained by reversing the passage of the water when being filtered, that is to say, the inlet water is forced again by its own pressure up the siphon-pipe, and enters the egg-shaped body from the top instead of by the bottom, and thus washes out the impurities that have accumulated in the charcoal beds.

The second illustration also shows this filter for domestic purposes, but where no town's water is obtainable. The water pressure is obtained by affixing a hand-pump, which is here shown.

The third illustration shows the apparatus for manufacturing concerns where larger quantities of water are required. The principle is the same, only the inlet water is made to rise simultaneously in two filters instead of in one.

The efficacy of these filters depends on the size of the inlet-pipe and the water pressure, but it is claimed that one of these patent high-pressure self-cleansing filters will,

With	¾	in. feed-pipe, filter		300	gallons	per day.
"	⅞	"	"	600	"	"
"	1	"	"	1,000	"	"
"	1¼	"	"	1,500	"	"
"	1	"	"	3,000	"	"
"	1¼	"	"	6,000	"	"
"	2	"	"	12,000	"	"

and for manufacturing or other purposes these filters are made to supply up to 250,000 gallons per day.

The Corporation of Derby are filtering with these filters at the rate of 10,000 gallons per hour. Hand or steam pumps can be attached to these filters. Their use to steam-boilers would purify the feed-water, and tend to prevent the scaling action, by taking the water from the hot well of a condensing engine, and filtering it before allowing it to pass into the boiler.

Having thus commented on the possibility of removing from water, by means of charcoal, all organic impurities and other matters held in suspension, and some of the mineral bases held in solution, a further application of this substance is found in its relations as "fuel." Owing to its intensity of heat, and other reasons, charcoal has been largely used in metallurgical operations, but since coal has cheapened production, the application of charcoal for these purposes has been restricted. For centuries past charcoal has been employed for smelting iron, indeed so much was it valued that Dr. Peat, in his "History of Staffordshire," treats the making of iron by means of "coal for fuel" as a matter of unfortunate experience. According to Smiles' "Industrial Biography," it was Dudley Dudley who, in 1621, first succeeded in smelting iron with coal, but his success left him a ruined man. The means of substituting coal for charcoal for the production of iron has, however, been a gain at the cost of quality, for it is asserted that with comparatively little exception all the better qualities of iron are imported from countries where charcoal is the fuel used in their production. It has been proposed to use peat charcoal, for the reason that the carbon of peat is identically the same as the carbon of charcoal made from wood, still there is but a very remote probability of charcoal ever being again exclusively used as fuel in iron smelting furnaces.[1]

For household purposes charcoal is used to a great extent as fuel in France, and considering the extensive peat bogs of the country, it is a pity that these cannot be successfully utilized, as of all the objects of peat works, the production of charcoal is the most important.

[1] *Vide* Samuel Baldwin Rogers' "Treatise on Iron Metallurgy."

THE STUDIES AND DISCIPLINE PREPARATORY TO THE PRACTICE OF THE TECHNICAL PROFESSIONS.

TO those charged with the care of youth, be they parents, guardians, or teachers, there is nothing more difficult to answer than the question, How shall we educate them, and through what discipline shall we put them, so that they shall be best fitted to carry out in practice, either in the workshop or in the office, that calling for which—to use a word now often, perhaps too often used—they have a decided "proclivity"? In other words, How should youths study for certain professions embraced in what are now known as the technical arts, as engineers, architects, surveyors, farmers, and the like? By the bare term "study," taken in conjunction with the title of our paper, it will be perceived that we mean a much wider and more comprehensive matter than is generally conveyed by it. As used by us throughout the series of papers we propose to offer for the consideration of our readers, it will embrace not only the theory but the practice, thence it will take up what we have named in our title as the discipline through which the pupil is to be put, a discipline which we hope to be able to show is of immense practical advantage in the after-life of the student, when he will be called upon not merely to design the work connected with his profession, but to guide or direct and control the labour, and to influence the conduct—using that term in its widest and best acceptation—of the men by which those works are to be carried out and practically executed.

The question is not seldom put, How best can youths under our charge as parents or guardians be educated, so that they can follow advantageously the callings for which they have clearly a decided predilection? This question, often and easily asked, is one not so easily answered, involving as it does so many and such important considerations. For example, it is quite an easy thing to say that a boy, having apparently a strong "liking," as the phrase goes, for design and for construction, should be an architect or an engineer, or having a love for plants or domestic animals, and for the pleasures and toils of a country life, should be a botanist, a landscape gardener, or a farmer. But *that* is not the kind of information which a parent or guardian requires. He is likely to know it, or is told it, so to say, in a thousand and one ways by the boy himself. What is wanted to be known is this, or something like this: How can the tastes or inclination of the youth be so cultivated and directed that the information which he may be taught to acquire in connection with this cultivation and direction be most useful to him in after-life, and so that the information will have a close and practical bearing upon the profession which he has so strong a desire to follow as the means of making his livelihood? All these points, and more which will be pointed out as we proceed, the parent or guardian wishes to learn, and between the knowing of them and the not knowing of them lies, or is likely to lie, the difference between time well spent and efforts wisely directed and the contrary—the difference, in fact, between the acquiring of knowledge which will be useful and that which will be the reverse in the daily routine of the profession or calling which the youth desires to follow out.

As a rule it may be stated, youths are put into the professional life, or apprenticed to callings, knowing little, often indeed with a profound ignorance, of those studies and facts the principles and basis of which they will be required to apply to and make use of in their daily work. And yet there is and must assuredly be information to be met with and at command somewhere, by virtue of which they may so previously cultivate their tastes and direct their education, that all they learn shall afterwards be found to have a directly practical value in the office, in the workshop, in the fields, or on the farm. There surely must be some way, for example, by which a youth having a desire and a determination to be an architect or an engineer, will have acquired such a knowledge of the sciences upon which their practice is based, and be made so fairly well acquainted with the routine through which he has to be trained alike in the theory and the practice of these professions, and of the best and quickest modes of learning what he ought to learn, that his advance will be made more rapid than if he commenced his office or workshop life absolutely ignorant of these important points. We believe that such information is at command, that this way of educating a youth can be followed out. It is not, to say the least of it, a flattering thing for us to think of in connection with the education of our youths that it may be taken as a pretty correct statement of a fact that there is a species of preliminary apprenticeship, so to call it, which should be gone

through with by our youths before they begin their actual apprenticeship; which, nevertheless, is not gone through with, nay, is not as a rule even thought of by the vast majority of our teachers and the parents or guardians who employ them. And yet the importance of this so-called preliminary apprenticeship it is impossible to over-estimate, calculated as it is to give a fair knowledge of one of the legitimate practices of their profession or calling. The more fully this first or preliminary apprenticeship is carried out, the more rapidly will the second be completed. It is the aim and object of the series of practical papers, to which this is a rough and ready introduction, to point out the details of this first or preliminary apprenticeship; and to show as briefly, yet as fully as may be, in what it consists and of what the nature is of that discipline of the mental and physical character to which we have alluded. We do not disguise from ourselves the difficulties of the task we have set before us, nor do we arrogate to ourselves the capability to completely master and overcome them. But we may lay claim to some practical knowledge of the subject of the necessities, so to say, of the case, and certainly to a thorough determination to make the best of it, so that what we give in connection with it shall be at all events given in such a way that it will be practically and usefully suggestive. We shall endeavour to throw together a variety of hints which, if carried out (and aided by the efforts of others who will supplement, complete, and fill up the details of which we may in some instances be able only to give the outlines), will be useful to the youth when he is called upon to follow out the practice and superintend the daily duties of the profession he may determine to adopt.

Practical Literature.

ECONOMIC GEOLOGY.[1]

PROFESSOR Page has produced a volume on applied geometry, which, especially to the practical man, is at once interesting and instructing. The arrangement in paragraphs under headings is admirable, enabling the reader at once to refer to the subject on which he desires information, while the busy man, if he takes the book up in a few moments of leisure, and opens it at random, will be certain to find something good, suggestive, and at the same time complete in a few short paragraphs; thus, under the heading "Mineral and geological value," we have the following excellent remarks as to the value of an estate :—

"The mineral wealth of an estate, we have said, may arise from various sources. Its superficial sands may be fitted for mortar, for moulding purposes, or for glass-making: its surface clays may be adapted for brick and tile making, or even for finer pottery uses; while its peat-earths and bog-marls may all be of value, if not for sale, at least in the improvement of its other field-soils. These superficial accumulations are too much neglected. A good field of brick-clay in the neighbourhood of a rising town may be worth thousands; a small estate full of sand hummocks in the suburbs of Edinburgh brought nearly as much to its proprietor for builders' sand as he paid for it; while the excavations were filled up with shot-rubbish, and the original surface-soil restored. Again, there may be dykes and bosses of greenstone and basalt valuable as road-metal; granites and sandstones suitable for building; limestones for mortar or for furnace flux; and limestones unfitted for these purposes on account of their argillaceous nature, may be eminently useful for their hydraulicity. If an estate lies on the coal formation, there is generally an effort made to estimate its mineral value; and yet in this respect how much caution is necessary may be seen from the high prices that the cannels have recently brought, relatively to the price of other coals, from the yearly increasing demand for fire-clays, and also from the rapid utilization of the bituminous shales, which in 1855 were of no account whatever, and are now, for the distillation of paraffine oil and other products, worth hundreds of thousands. Lastly, an estate may derive its value from the occurrence of metalliferous veins and stream-drifts, and though these may have been worked and known, yet new values are constantly being attached to certain ores from their wider application in the arts, and their consequently increasing demand."

At the end of each section is a list of works, which the reader may consult who wishes for more exhaustive information than a short and comprehensive treatise can pretend to. This is a special feature which we highly commend. We have taken the volume up and put it down, and taken it up again, many times for a few moments, and each time we have done so with interest and pleasure.

[1] *Economic Geology, or Geology in its relation to the Arts and Manufactures.* By David Page, LL.D., F.G.S., &c. William Blackwood, Edinburgh and London. 1874.

POLARIZATION OF LIGHT.[1]

THE subject of polarization of light and its attendant phenomena, forms one of the least pertectly understood branches of the beautiful and interesting science of optics. We therefore welcome with pleasure this treatise upon it by one who has devoted a very considerable amount of attention to the subject.

The work before us contains in a small compass a large amount of information upon the phenomena of polarized light, but we must confess to some little disappointment as to the manner in which that information is conveyed. The author informs us that his book contains the substance of lectures delivered at various times to his workpeople, and constitutes a talk rather than a treatise on polarized light. From this we were naturally led to suppose that we had here a popular exposition of the subject. A glance at its pages, however, sufficed to dispel this illusion, and we can only say that if Mr. Spottiswoode's workpeople thoroughly understood these lectures, they must be far above the average of the working class in scientific attainments. To the student who possesses a thorough knowledge of the principles of optics, it will doubtless prove very useful, though even he will have to give it very close attention before he can thoroughly comprehend its contents; while to the general reader we fear it will be nearly unintelligible. The author also plunges at once *in medias res*, instead of giving, as would, we think, have been preferable, an introductory chapter on the wave theory of light, without a perfect comprehension of which no one can hope to obtain any knowledge of the phenomena of polarization. The work, which forms one of the well-known "Nature Series," is well got up, and contains a well-executed chromo-lithograph of the colours produced by the action of various crystals in polarizing light.

[1] By William Spottiswoode, M.A., LL.D., F.R.S., &c. Macmillan and Co. 1874.

THE HANDY SCHOOL DICTIONARY.[2]

A VERY cheap and useful little volume, which we trust will supersede such valueless works as those illustrated pronouncing dictionaries with which the market has been recently flooded, and which we believe, notwithstanding their grave defects, meet with considerable sale. Although designed especially with reference to scholastic requirements, it will not be without usefulness for more general purposes, the Appendices containing much information of the kind which we all ought to know, which we all at times forget, and which therefore should always be at hand.

We have recently in these pages referred to the typographical qualities which characterize our author's other similar compilations, and we have only to say that these qualities appear to still greater advantage in the present volume, while its philological excellences are such as should commend it to students and teachers alike

[2] *The Handy School Dictionary, Pronouncing and Explanatory, for use in Elementary Schools.* By the Rev. James Stormonth, author of "The Etymological and Pronouncing Dictionary of the English Language," &c. William Blackwood and Sons. 1874.

Special Correspondence.

PARIS, *December* 21, 1874.

THE IRON AND STEEL TRADE.

THE Ponsard Furnace.—I beg leave to give to the following announcement of a great progress and success, the form in which it reached me, that of a letter addressed to me by one of my faithful subscribers, M. Pelegri, iron-master at Toulouse :—

"It is now three years since I read in your 'Mondes' an article upon M. Ponsard's furnace applied to the manufacture of steel and to the re-heating of iron. Being myself proprietor of the hydraulic works known by the name of the

'Basacle flatting mills,' at Toulouse, I saw in your article something new, which I determined to try, and after consulting an eminent engineer, M. Jordan, professor at the 'Ecole Centrale,' I proceeded to set up at my works one of M. Ponsard's furnaces for welding and re-heating iron. This furnace has been at work for the last two years, and the results obtained are therefore thoroughly practical, and are not mere experiments. The economy of fuel has constantly amounted to 52 per cent. The waste is reduced one-third or one-quarter of what it was with the old furnaces. The furnace works three months at a run without stoppage. The longest repairs which had to be effected at the end of that time, including extinction and re-lighting, never exceeded a fortnight. The roof of the furnace, constructed of bricks of pure silica, by M. E. Muller, of Ivry, it is incredible to say, has now been in use for *two years* without being in the least damaged.

"It is but just to add, that if the Ponsard system were required to take the place in a mill of furnaces whose waste heat is utilized to produce steam, the economy of fuel would not be so great, because it would be necessary to heat the boilers without having recourse to the waste heat of the furnace; but even then there would be an economy of 25 per cent. of fuel, and the economy of waste would remain the same.

"The Ponsard system is very simple, not easily put out of order, explosions are out of the question, and there are no valves to be worked.

"In one word, Monsieur l'Abbé, I am most glad to have adopted the Ponsard furnace, and as it is to you that I owe the idea, I wished to thank you for the good you have done. A report upon the Ponsard system will be read at the next meeting of the Society of Civil Engineers, by M. Périssé, engineer, director of the Ponsard Company, and I was desirous that before reading the account of my success in the bulletin of the society, you should be informed by me that it is to you that I am indebted for it."

For many years the metallurgical engineers of all countries have been endeavouring to treat iron ore in reverberating furnaces instead of in smelting furnaces, which are extremely expensive, and require exclusively the use of coke or charcoal, the prices of which augment daily. One is obliged to admit, that notwithstanding the efforts of Bessemer, of Siemens, of Martin, and of so many others in Europe, as well as in the United States, the solution of this important problem seemed as far off as ever; but we are glad to see that the Ponsard furnace seems to fulfil the necessary conditions.

On the 27th of last September, at the iron-works of Verrières (Vienne), belonging to M. de Beauchamp, the first run of cast iron was obtained by means of M. Ponsard's direct treatment of iron ore in a gas reverberating furnace. The operation was effected under the direction of M. Ponsard, aided by M. Périssé, director of the General Metallurgical Company of Paris, Boulevard Haussmann, 33. The apparatus consists principally of a gazogène, which transforms the fuel by which the operation is effected, and of an apparatus made of bricks, called the heat recuperator, which receives the waste flames from the furnace, and gives back the heat in the shape of hot air. Six compartments serve successively for the reduction of the ore, for the different reactions which must take place, and, lastly, for the complete fusion of all the substances, so that their separation may become possible by reason of their different densities.

The different phases of the operation can be easily followed, and are at once evident by a first glance at the apparatus. On the side of the charging doors, the temperature is only red; but a little further on it attains such an elevation that it is impossible to look into the furnace without being dazzled. This temperature is estimated to be about 2,000° centigrade (3,000° Fahrenheit). The success of the operation was even greater than had been anticipated, and the result obtained at Verrières proves the possibility of obtaining steel directly from the ore, without passing through all the transformations hitherto used. This evidently constitutes a new and very important revolution in industrial metallurgy.

Nitrate of Methyle and the Saint-Denis Explosion.

This accident occurred at the colour works of M. A. Poirrier at half-past six on the morning of Thursday, the 19th of November last.

Nitrate of methyle is nitric ether of the series of methylic alcohol, or spirits of wood. It is prepared by causing a cold mixture of methylic ether and concentrated sulphuric acid to fall in a very thin stream into spherical glass receivers containing nitrate of potash, and heated in a water-bath by a current of steam to a temperature of 176° Fah. Only 80 kilogrammes could be manufactured daily in twelve receivers, the operation being divided into two parts. During the last three years upwards of 80,000 kilogrammes of this substance had been thus manufactured, and no accident had ever taken place.

After being subjected during several hours to the contact of chloride of calcium, to which body it readily abandons whatever quantity of water it may contain, as well as such excess of methylic ether as may still be in combination with it, the nitrate of methyle was placed in a closed boiler communicating freely with the worm of a still, and subjected to heat in a water-bath, through which passes a current of steam. A sort of rectification then takes place in the following manner: 220 kilogs. of nitrate of methyle are heated during 1 to 1½ hours, so as to purify it, after which the heating is discontinued, the water-bath emptied, and the vessel allowed to cool until the morrow, when from 210 to 212 kilogs. of pure nitrate of methyle will be found to remain.

The day preceding the accident, the operation above described had been effected, and the workmen had received, as usual, the most stringent orders not to proceed to draw off the cooled mass until daylight. But the two workmen charged with this duty had the unfortunate idea of getting the job over, and proceeded to empty the boiler before daylight, and they had already accomplished one half of the operation, which consists in drawing off the liquid by means of a syphon and decanting it into carboys, when one of the two approached the lantern he held to the *opening* of the boiler, to see how much remained in it.

Nitrate of methyle is a body which boils at 150° Fah., and gives off vapours at ordinary temperature, which vapours detonate when they are heated above 302°. There was first of all inflammation of the vapours mixed with the air, then inflammation of the liquid itself, and instantaneous production of an enormous quantity of vapour, which almost immediately detonated, overthrowing and setting fire to the building and to the adjoining shed, in which was stored up some more nitrate of methyle, a large quantity of nitrate of potash, two tons of light oil of coal, and 400 kilogs. of methylic ether.

It was therefore not a case of *a liquid raised to a high temperature under considerable pressure.* Nitrate of methyle had been employed for the last three years at M. Poirrier's works, to take the place of the iodide of methyle, which is extremely expensive (since 1871 the price of iodine has risen to about 40s. the pound), in the transformation of violet methylaniline, or Paris violet, into that most brilliant of all colours, the vert-lumière, or luminous green, which possesses the peculiar property of retaining its colour by candle or gas-light as well as by day.

New Magneto-Electric Machine for the Mechanical Production of the Electric Light, and of Voltaic Electricity.

The electric light, which is so intense and so cheap, when it is produced by motion transformed into electricity by means of magnets, has not yet said its last word, on the contrary it is still in its infancy; in the end it will no doubt be used all over the world for illuminating lighthouses, ships, and workshops; nor must the immense services rendered by electricity during the siege of Paris be forgotten. We are, therefore, happy to hear that M. Garnier, who has so long been attached to the Alliance Company, and who has acquired so much experience in the construction and working of magneto-electric machines, has just joined and entered into partnership with one of our most skilful engineers and electricians, M. E. Hardy, 6, Avenue de Lamothe-Piquet, and they are about to construct a new mechanical generator of electricity of a very perfect kind, which may perhaps very nearly approach the desideratum. Their principal model or type of a magneto-electric machine is 1 m. 35 in height, 1 m. 25 in width, and 1 m. 10 in length, that is to say, very little over a cubic metre in bulk. This machine is so solidly put together that it is impossible for it to get out of order, and it can be removed anywhere ready for action without having to be taken to pieces, which is an immense advantage. To be put in motion it requires a force of 2½ to 3 horse power. In order to produce its maximum effect it must make from 400 to 450 revolutions per minute, and then gives a light equal to that of 250 Carcel burners, consuming each 1⅓ oz. of oil per hour; and this intense light, so absolutely constant and steady, can be obtained by the expenditure of a few pounds of coal. When the machine is required to produce continuous currents, and always in the same direction, for electrotyping purposes, for instance, it is necessary to adapt a commutator of a new form, extremely durable and efficacious. The price of the standard model, with four series of sixteen coils and sixteen magnets, is reduced to 6,000 francs (£240). This appears to be a heavy price, but it is in reality a very moderate one when it is considered that this machine produces torrents of electricity and of light, that it loses none of its power by work, and can never wear out.

F. Moigno,
Canon of the Chapter of Saint-Denis